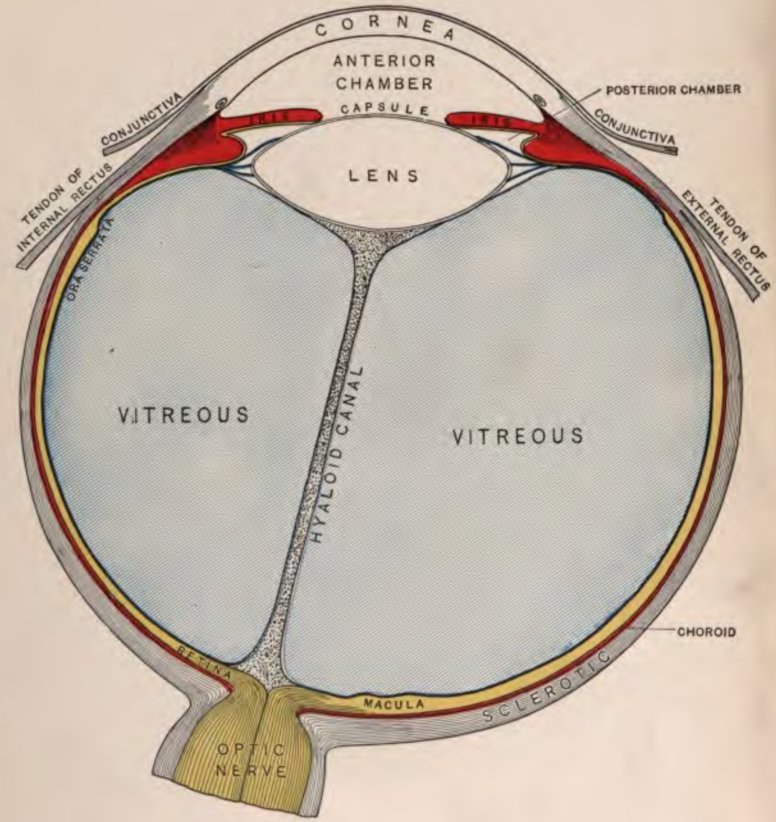
PLATE I.



The Right Eye in Horizontal Section, showing the upper surface of the lower segment. Diagrammatic. (Testut.)

A

MANUAL

OF

DISEASES OF THE EYE

FOR

STUDENTS AND GENERAL PRACTITIONERS.

BY

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PREFACE.

In the preparation of this Manual the author has endeavored to present in a systematic, practical, and concise manner those facts concerning Diseases of the Eye which will be of most service to students and practitioners of medicine.

It is somewhat difficult in a book of this size to decide what is best to include and the amount of space to be allotted to each subject. The author has been largely guided in these matters by his personal experience in teaching both under-graduate and post-graduate students. By the avoidance of extended discussions and unsettled theories space has been gained for the presentation of subject-matter of the greatest utility to those for whom the book is intended.

The author is especially indebted to the Eye portion of Drs. Miller, McEvoy, and Weeks' *Diseases of the Eye, Ear, Nose, and Throat.* Some of the valuable material contained therein has been freely utilized in the preparation of this work. The author has also drawn upon some of his previous contributions, notably, *A Manual of Ophthalmic Operations as Practised on Animals' Eyes,*

and the chapter on "General Preparation for Ophthalmic Operations" in Posey and Wright's *Diseases of the Eye, Nose, Throat, and Ear.* Many of the standard text-books and systems have also been consulted, to which the student must be referred for a more comprehensive knowledge of the subject.

C. A. V.

PHILADELPHIA, April, 1903.

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ABBREVIATIONS AND SIGNS EMPLOYED IN OPHTHALMIC LITERATURE.

A.	Accommodation.
Am.	Ametropia.
As.	Astigmatism.
As. H.	Hyperopic astigmatism.
As. M.	Myopic astigmatism.
Ax.	Axis (cylindrical lens).
B.	Base (prism).
Cyl. or C.	Cylindrical lens.
cm.	Centimetre.
D.	Dioptre.
E.	Emmetropia.
H.	Hyperopia.
M.	Myopia.
M. A.	Metre angle.
mm.	Millimetre.
O. D. (R. or R. E.)	Oculus dexter (right eye).
O. S. (L. or L. E.)	Oculus sinister (left eye).
O. U.	Oculus utrique (both eyes).
P. p.	Punctum proximum.
P. r.	Punctum remotum.
Pr.	Presbyopia.
Sph. or S.	Spherical lens.
T.	Tension.
V.	Vision.
$+$	Plus, convex lens.
$-$	Minus, concave lens.
$=$	Equal to.
$\bigcirc$	Combined with.
$^\circ$	Degree (prism).
∇	Centrad (prism).
Δ	Prism dioptre.
$''$	Inches.
$'$	Feet.

DISEASES OF THE EYE.

CHAPTER I.

EXAMINATION OF THE EYE, OBJECTIVE AND FUNCTIONAL.

It is not necessary in every case of ocular disease to make a complete and systematic examination. In most of the simple cases the condition will be discovered at once, and many of the objective and functional tests may be omitted. In obscure and complicated cases, however, it is much better to make complete observations concerning the ocular conditions in a systematic manner.

History. Inasmuch as in most cases it is impossible to carry the appearance of an eye from day to day in one's mind, it is better to keep an accurate history of each case, and record the conditions at the time they are observed. In the simple cases the history may be short, containing a description of the condition pertaining to the particular disease with which the eye is affected; in other instances, however, the history should be complete. It matters not whether the history is kept in books or whether the card-index system is employed, for the latter is so convenient in all of its particulars that it seems to be taking the place of the large volumes which were formerly used.

It is well, for obvious reasons, to record the name and residence of the patient; the age, sex, race, and whether married or single, may also have some bearing upon the disease which is being investigated. The family history should be inquired into, and any hereditary conditions

noted. The personal history of the patient, including any attacks of severe illness or any deviations from the normal functions of the body, should also be recorded. The question as to whether the occupation of the patient has anything to do with the ocular disease, as well as the habits of the patient as regards the excessive use of toxic substances, must be determined. Any nervous phenomena should be carefully investigated. The present condition of the eye as well as any former abnormal conditions should be noted, according to the methods hereafter to be described. Any changes from the condition observed at the first examination should be recorded in the history upon each date that the new observations are made.

Direct Inspection. **The Lids** should be carefully inspected first for any abnormalities, their edges should be examined for any ulcers or crust formations, and it should be noted whether or not there has been some loss of the cilia, or whether any are misplaced. If any of the superficial veins are swollen, or if either of the lacrymal punctæ are closed or misplaced, the condition should be noted. The mobility of the lids should also be determined in order to ascertain whether their edges approximate, so that the cornea may be completely covered.

The Region of the Lacrymal Sac is next inspected for redness or swelling, slight pressure being made over the sac in order to ascertain whether any abnormal secretion can be expressed through the lacrymal punctæ. The condition of the lacrymal gland is also to be examined.

The Eyelids are Next Everted so that their under surface may be examined. This manœuvre is performed by having the patient look directly downward toward his lap, while the surgeon with the thumb and index finger of the left hand seizes the eyelashes and draws the eyelid downward and outward from the eyeball, at the same time making slight pressure with the thumb of the right hand behind the upper border of the tarsal cartilage. An upward movement of the lid margin, with the thumb acting as a fulcrum, will now evert the lid, showing the palpe-

bral portion of the conjunctiva. In those cases in which the cilia have been lost it is necessary to seize the margin of the lid and to employ something like a match-stick or lead-pencil to take the place of the thumb of the right

FIG. 1.

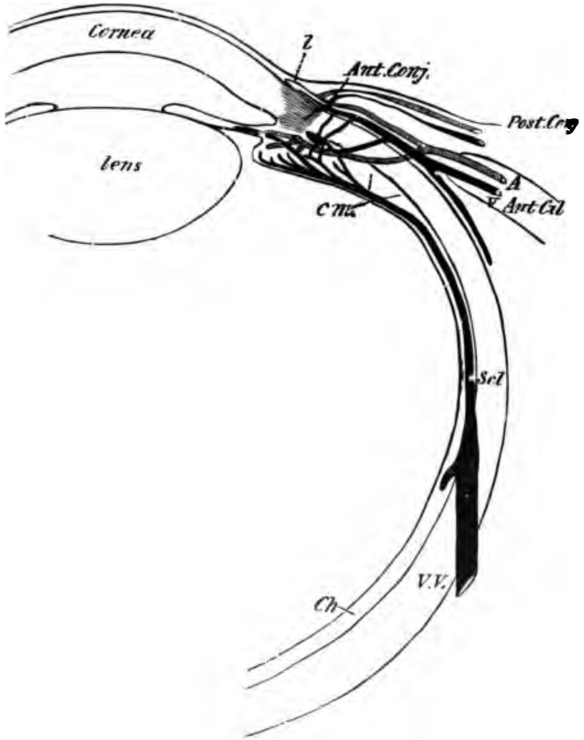
Method of holding the upper eyelid after eversion. (Wells.)

hand. Any abnormal condition as regards foreign bodies and granulations, either on the tarsal conjunctiva or in the retrotarsal folds, should be carefully looked for. The caruncles and semilunar folds must also be examined at the same time for any abnormal conditions.

The Ocular Conjunctiva is inspected for any swelling or engorgement of its bloodvessels, and the character of such engorgement noted. In normal conditions only a few conjunctival bloodvessels can be observed, but in abnormal conditions there may be very great engorgement. The blood supply has been divided into three systems: *System I.* represents the posterior vessels of the conjunctiva, which are much coarser than the anterior vessels, freely mobile over the underlying sclera, and the engorgement of which produces a bright red appearance, which lessens as the cornea is approached. This is the system which is principally involved in conjunctivitis, and is, therefore,

usually associated with more or less secretion. *System II.* represents the anterior ciliary vessels, which are composed of the perforating and non-perforating arteries and veins. It is the engorgement of the latter vessels which produces

FIG. 2.



Vessels of the front of the eyeball. *c.m.* Ciliary muscle. *Ch.* Choroid. *Scl.* Sclerotic. *V. V.* Vena vorticosa. *l.* Marginal loop-plexus of cornea. *Ant.* and *Post. Conj.* Anterior and posterior conjunctival vessels. *Ant. Cil. A.* and *V.* Anterior ciliary arteries and veins. (Simplified and altered from Leber.)

the so-called "pericorneal zone" in affections of the iris, and the violaceous tint surrounding the cornea which is frequently seen in glaucoma or cyclitis. This reddish,

or violet zone, formed by engorgement of System II., is composed of very fine rather than of coarse vessels, and its intensity diminishes in proportion to the distance from the corneal margin. *System III.* is composed of the anterior conjunctival vessels, and the circumcorneal capillaries derived from the anterior ciliary vessels, the engorgement of which manifests itself in a bright red "pericorneal zone." There is slight anastomosis by means of small branches between Systems I. and II., and these are the bloodvessels which become engorged in the various corneal inflammations.

The Cornea is next examined for any unevenness of its surface or loss of transparency. The surface may be roughly tested by standing the patient directly in front of a window, so that the image of the latter will be reflected upon the surface of the cornea. If the lines of the image are broken, bent, or distorted, the surface of the cornea is irregular. If, however, they appear normal, the surface of the cornea is even. A much more accurate test may be made by means of a keratoscope, which is a round disk with a hole in the centre, surrounding which are a number of concentric circles. The observer's eye being placed behind the central opening, the light is reflected from the surface of the disk to the cornea. It can be readily noted whether the circles thus pictured on the cornea are regular or whether they are broken or distorted. The instrument is also known as Placido's disk (Fig. 3).

If any *abrasion of the cornea* is suspected, it may be definitely determined whether or not such condition is present by dropping upon the cornea one or two drops of a 2 per cent. solution of fluorescine. If the corneal epithelium is unbroken no change will result from the instillation; if the corneal epithelium is denuded, however, the denuded portion will stain a bright green. This is also a satisfactory means of diagnosing between ulcerated conditions of the cornea and the scars resulting from previous ulceration.

In examining and in treating the eyes of young chil-

dren it is sometimes necessary to employ a certain amount of force, in order to obtain a satisfactory view of the cornea. Under these circumstances it is best to permit the child

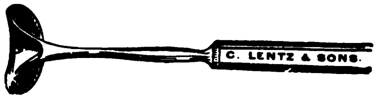
FIG. 3.

Placido's disk.

to lie across the mother's or attendant's lap, as she sits facing the surgeon, with the head in the surgeon's lap, face upward, the surgeon being protected by a rubber sheet or pillow. One arm of the attendant can be used

to control the feet, and the other the hands of the child, thus leaving the surgeon the free use of both hands for examination or treatment. The lids may be more satisfactorily elevated by employing an instrument devised for the purpose.

FIG. 4.

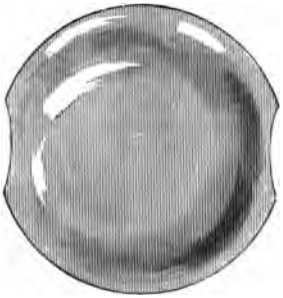


Desmarres' lid retractor.

In certain conditions the *sensibility of the cornea* is more or less diminished, and this may be tested by gently touching the cornea with a wisp of absorbent cotton and noting whether or not the reflex action of the lids is as quickly produced as in a normal eye. If any anæsthesia of the cornea is found, further investigation should be made regarding the sensibility of the surrounding portions of the face.

Oblique illumination is a most satisfactory method of examining more closely the conditions of the cornea,

FIG. 5.



Biconvex condensing lens.

which cannot be distinctly observed with the naked eye. It may be done by means of two strong magnifying lenses or by means of a magnifying lens and a corneal

loupe. The patient is seated a short distance to the side and slightly behind the light from an Argand burner; the light is then focused upon the cornea by means of a condensing lens, while the observer studies the corneal conditions through another condensing lens, or through a loupe held at its focal distance in front of the eye. The

FIG. 6.

Corneal loupe.

distance of each lens is varied from time to time in order to get more or less intense illumination and greater or lesser magnification. By this method any minute changes of the surface or of the substance of the cornea can be readily detected, and the condition of the anterior chamber, the iris, the anterior capsule, and the anterior portions of the lens may be studied.

The condition of the anterior chamber should be examined as regards any changes in the aqueous humor or the presence of any foreign substances.

The Iris. In examining the iris, the color should be noted as well as any difference between the two eyes or between different portions of the same iris. There may be considerable difference between the color of the two irides, or there may be segments of different color in the same iris with perfect health of the patient. A number of irregular dark spots may be observed upon the iris, to which condition the name *piebald iris* has been given. If the iris is diseased it is likely to be irregular on its surface and the color of a greenish or greenish-yellow tint.

The Pupil. In health the size of the pupil varies with many conditions, such as exposure to light, accommoda-

tion, convergence, and the condition of refraction. The average diameter of the pupil, with the accommodation at rest, is between 4 mm. and $4\frac{1}{2}$ mm. One pupil may be slightly larger than its fellow without any abnormal condition in the health of the patient. The size of the pupil may be measured by means of a millimetre rule, or by a pupilometer, consisting of a disk with a number of holes of various diameters, with which the pupil is compared.

Movements of the Pupil. The pupillary reactions should be carefully tested, as they frequently throw important light upon the existence of various diseases. The most important are the following:

Fig. 7.

Pupilometer.

1. *Direct Reflex Action.* If the patient faces a strong light, daylight being preferred, and each eye covered and uncovered separately, as the rays of light enter the pupil a marked contraction will be noted. The repeated contraction and dilatation of the pupil for a few seconds after the stimulus has been removed is called *hippus*.

2. *Indirect Reflex Action (Consensual).* If the patient faces a strong light (both eyes being covered), as one eye is uncovered and the light permitted to enter, not only will this pupil contract, but the pupil of the other eye, which still remains covered, will contract likewise.

3. *Associated Action.* The size of the pupils is noted with the patient looking into the distance. He is then directed to change his vision quickly to a small object held a few inches from the eyes, when, under normal conditions, the pupils will be seen to contract. This is sometimes called *the reaction in accommodation and convergence,* although the action is not observed in accommodation which is unassociated with convergence. In the *Argyll-Robertson pupil,* observed in tabes dorsalis, the associated action is present, but the direct reflex action is absent.

4. *Pain Reaction; Skin Reflex.* If the patient is made to face a bright light, thus producing contraction of the pupils, they will dilate if some stimulation of a cutaneous nerve is produced. The test may be made by pinching the skin of the neck or by employing a faradic current.

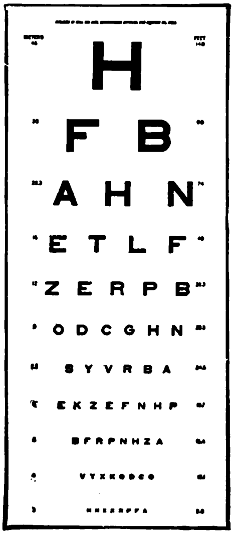
5. *Action of Drugs.* Certain drugs have the power to dilate the pupil (*mydriatics*), and other drugs have the power to contract the pupil (*myotics*).

These *movements of the pupils* are very complex. Contraction is produced by nervous impulse to the pupil sphincter through the myotic tract, the movement being involuntary and produced by certain stimuli.

The *myotic tract* has its origin in the oculomotor nucleus, passing by its short root to the lenticular ganglion. From this point it passes to the pupil sphincter through the short ciliary nerves. If this tract is stimulated, extreme myosis results; if it is divided, moderate mydriasis is obtained. The routes over which an impulse produced by exposure of the eye to light must travel to produce contraction of the pupil are the *afferent* and the *efferent paths.* The *afferent impulse* passes along the optic nerve, the chiasm, the optic tract of the same side (and, perhaps, of the opposite side), probably by way of the corpora quadrigemina and Meynert's fibres, to the oculomotor nucleus. It is here that the *efferent path* (myotic tract) begins and through which the impulse is carried to the pupil.

The *mydriatic tract* has its centre in the medulla oblongata, from which it passes down the spinal cord to the second dorsal nerve, thence along the communicating branch of this nerve to the cervical sympathetic and the plexus around the internal carotid artery. From this point it passes to the pupil by the nasociliary branches of the nasal nerve, from which the pupil mydriatic fibres are supplied by the long ciliary nerves. If this tract is stimulated, extreme mydriasis results; if it is divided, moderate myosis is obtained.

FIG. 8.



Test card for distant vision.

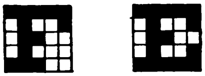
The blood supply of the iris also influences the size of the pupil. If it is increased, we have moderate contraction; if it is diminished, we have moderate dilatation.

Visual Acuity represents that power which the eye has of seeing distinctly different objects at different distances. The *sense of sight* is represented by the ability to distinguish *light, form,* and *color.* The *light sense* is the ability

to perceive illumination of different degrees; the *form sense* is the ability to perceive the shape of different objects; and the *color sense* is the ability to distinguish the different colors. Visual acuity may be divided into *central vision* and *peripheral vision.*

Central or Direct Vision is the vision which is obtained when an object is directly observed, its image falling upon the macula lutea. The acuity of vision is tested for both distant and near objects. *Distant vision* is tested by means of letters which have been made of different sizes, so that the test may be made at different distances. The letters are large, and are usually black on a white ground. They are numbered according to the distance at which they are to be read, the larger naturally being read at a greater distance than the smaller. These letters are so constructed as to subtend an angle of 5′, because it has been shown by various observations that the normal eye can distinctly see an object of this size. Each portion of the letter is made to subtend an angle of 1′, or one-fifth of the whole (Fig. 9). Inasmuch as in some cases it has

FIG. 9.



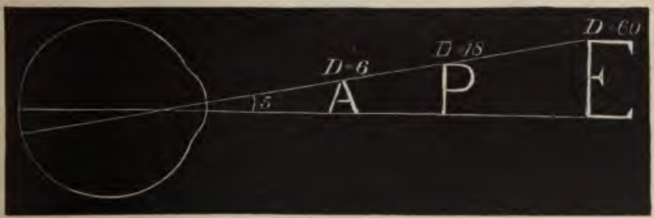
Snellen's test types.

been found that individuals with normal eyes can read letters somewhat smaller, some test cards have been made with letters which subtend an angle of 4′. Fig. 10 shows how this angle is constantly maintained for different distances, the angle being formed by lines from the extremities of the object crossing at the nodal point of the eye.

In testing the central vision it is customary to seat the patient six metres (about twenty feet) distant from the card, and, having covered one eye, to have him read the lowest line which can be seen. The result is usually expressed by a fraction, the numerator of which is the distance the patient is placed from the card, and the

denominator of which is the numeral index of the line which he reads on the card. Thus, if he is six metres distant and reads the six metre line, V=6/6; if, however, he could not read this line V would equal 6/12, 6/9, or whatever line he was able to read. Likewise, if the test were being made at a distance of twenty feet the result would be expressed as $\frac{20}{XX}$, $\frac{20}{XL}$, $\frac{20}{CC}$, etc. If the patient's vision is not sufficiently good to read any of the test letters at this distance, the card is moved toward him until he can read the top line, when the distance between the card and himself represents the numerator of the fraction, and the number of the top line on the card the denominator of the fraction, indicating the amount of his

Fig. 10.



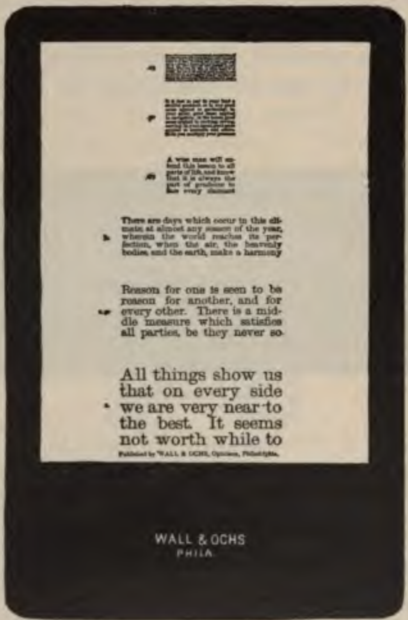
The visual angle.

vision. Thus, if the card be brought to within ten feet before the top line can be read, and this line should be read by a normal eye at a distance of two hundred feet, the vision would equal $\frac{10}{CC}$. If he should be unable to distinguish any of the letters on the card at any distance, he is then asked to count the fingers on the hand, which are held at different distances between him and the light. The result is expressed as "*counts fingers at ten inches,*" or whatever the distance may be. If he cannot count the fingers it is noted whether he can detect the moving hand, and if so, at what distance, and the result is expressed as "*moving objects at six inches,*" or whatever the distance may be. If vision is so deficient that moving objects can-

not be distinguished, it is necessary to ascertain whether distinction can be made between light and darkness. If light is perceived the result is expressed as "*perception of light*," or *L. P.*

For illiterate persons and for young children, cards containing arithmetical figures, incomplete squares, or well-known objects, as birds, dogs, chairs, etc., made according to the same principle, may be employed.

FIG. 11.



Test card for near vision.

In Testing Near Vision, or the Power of Accommodation, a test card with smaller type of different sizes is employed, each letter having been constructed according to the method just described. With one eye covered, the patient is instructed to bring the card as close to the eye

as he can and yet read distinctly the smallest type he can see. The distance of this type from the eye is then measured, and represents the *punctum proximum*, or *near-point.* If the card is now pushed away from the eye, the most distant point at which the same type can be read represents the *punctum remotum*, or *far-point.* The power of accommodation diminishes with advancing age, the near-point receding further and further from the eye, until at about the seventieth year it is entirely lost.

Color Sense is the power which the retina has of distinguishing between different colors and between different shades of color. *Color-blindness* is a subnormal or totally deficient color sense, and is characterized by an inability to distinguish between certain colors or shades of color. The most frequent variety is that in which there is an inability to recognize the various shades of green and red. Many tests have been devised for the detection of color-blindness, the method of Holmgren being the one which is most frequently employed, and which consists in testing the ability of a person to match various colors. A large number of skeins of colored wool, consisting of different shades of all the principal colors, are mixed together. In the lot are three test skeins, viz., a pure light green, a rose-purple, and a red. There are not only many skeins of the same color, but of different shades of each color.

To make the test, the wools are mixed together in good daylight, and a skein of the test color is placed to one side, the patient being asked to pick out all the skeins of a similar color. He is particularly instructed that the *shades* do not have to be similar to the test skein, but that the *color* must be the same.

The *first test* to be made is to have him match the *green* skein, and the examination must not be discontinued when a few skeins have been taken from the pile and placed beside the test skein. The patient must understand that it is necessary to pick out from the large pile of wools all the skeins that match the green test skein in color. If the patient matches the test skein with other colors

than the green, for example, gray, light pink, or yellow, his color sense is deficient; that is, he is *color-blind.*

The *second test* is to have him match the *rose-purple,* the examination being made exactly as before. If, with the purple, the patient selects blue or violet skeins, he is *completely red-blind.* If, however, he should select with the purple the green or gray skeins, which incline to blue, he is *completely green-blind.* The patient who is red-blind never selects the same colors as a green-blind patient; likewise a green-blind patient never selects the same colors as one who is red-blind.

The *third test* is to match the *red.* It is a test which is employed for those who are completely color-blind. If the patient is *red-blind,* he chooses in addition to the red skeins the green and brownish colors, which appear darker than red to a person with normal color sense; if he is *green-blind,* he selects shades of those colors which appear to the normal eye lighter than red.

Many other tests have been devised to serve different purposes, notably the arrangement of yarns by Dr. William Thomson for the examination of railway employés, which may be employed either by the ophthalmic surgeon or by one not skilled in such examinations. In addition, as many individuals in whom it is necessary to have good color sense are obliged to detect the colors of lanterns at different distances, a *lantern test* has been devised which consists of a white light, in front of which may be superimposed glass disks of different colors and shades.

An examination for color-blindness is of the greatest importance in individuals who are connected with railways, navigation, and general signal service, where signals of different colors are employed, as one who is color-blind is thereby rendered unsuitable for such service.

Peripheral or Indirect Vision (Field of Vision). The field of vision is represented by that space from which the images of all objects fall upon the retina, with the eye fixed upon a given point. The limit of the field of vision

is the outer boundary of this space. It may be *roughly tested* in the following manner: Placing the patient directly in front of the observer with the eyes of each upon the same level, one eye of the patient being covered, he is asked to fix constantly the observer's eye, the right eye of the patient fixing the left of the observer, and *vice versa*. The distance between the observer's eye and the patient's eye should be about eighteen inches or two feet. The fingers of the observer are now approached from each side, and from above and below in a plane midway between the two eyes toward an imaginary line connecting them, and the patient directed to tell as soon as the approaching finger is distinguished. If the observer's field of vision is normal and both observe the finger at the same time, the patient's field is also normal. If, however, the patient does not observe the approaching finger until it has been observed by the examiner, the field of vision is more or less contracted. Instead of using the finger as a test object, other objects may be employed, a very good one being a piece of thick, white card-board about 1 cm. square, fastened to the end of a stick for a holder.

The field of vision may also be mapped out by means of a black-board containing a number of squares, each square being so drawn as to represent a certain number of degrees in the perimeter semicircle. With the patient's eye 25 cm. from the black-board, and focusing a small cross in the board's centre, one eye being covered, the test object is approached from all directions in the same plane, and as soon as it can be observed by the patient a mark is made upon the black-board indicating the position. These points are afterward connected, thus giving a map of the limits of the visual field.

The usual method, however, of determining the field of vision is by means of an instrument known as the *perimeter*. There are many forms of the instrument upon the market, some being self-registering. The instrument is usually placed upon a stand, which can be lowered or elevated according to the height of the patient. It con-

sists of a chin rest, 30 cm. distant from which is the centre of a semicircle indicated by a white spot which the patient constantly fixes with his eye during the examination. This semicircle can be rotated around its axis, and has on its outer surface a scale in degrees. In that type of the instrument which is self-registering there is connected

FIG. 12.

McHardy's perimeter. (Juler.)

with the perimetric arc a disk upon which is placed a perimeter chart, consisting of concentric circles corresponding to the degrees upon the perimetric arc. Upon the semicircle of the perimeter there is a carrier which contains the objects with which the field of vision is to be tested.

As these move from the periphery to the centre in various meridians, the patient always fixing the central point until they are observed, a small register is automatically moved at the same time to all points of the perimeter chart corresponding to similar points on the perimetric arc, any point thus being accurately noted. Test objects vary in size, and may be either round or square. The sizes most frequently employed are 1 cm., ½ cm., ¼ cm., 2 mm., and 1 mm. When the vision is much reduced it is necessary to employ larger test objects, and when only light perception remains the field of vision is tested by means of two candles, one being used for the patient to focus his eye upon, and the other for approaching from the various meridians in a manner similar to that in which other test objects are employed.

The field of vision is tested with *colored objects* as well as with white objects. When the test is made with white objects, we speak of the limits so secured as representing the *form field;* when tested with colors, we speak of the limit of the visual field for the color employed, or the *color field.* In the order in which they are observed by normal eyes from without inward they are as follows: White, blue, yellow, red, green, and violet. In studying the visual field, however, it is rarely necessary to employ more test objects than the white, blue, red, and green. The limit of the visual field under these circumstances is as follows, when measured with a test object 1 to 2 cm. in diameter:

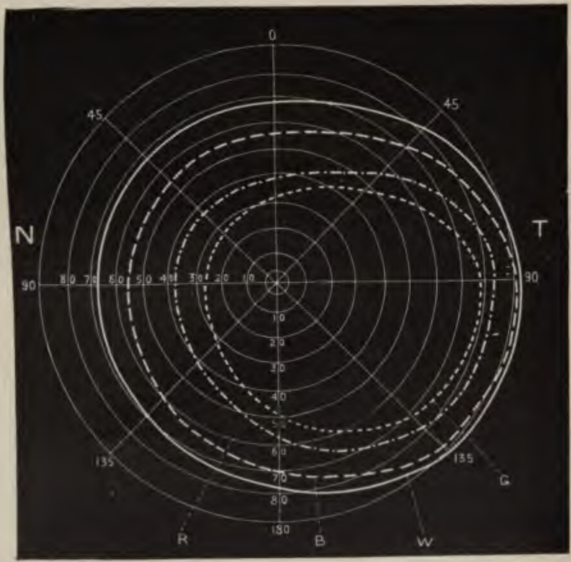
	White.	*Blue.*	*Red.*	*Green.*
Outward	90	80	65	50
Outward and upward	70	60	45	40
Upward	50	40	33	27
Upward and inward	55	45	30	25
Inward	60	45	30	25
Inward and downward	55	50	35	27
Downward	72	58	45	30
Downward and outward	85	75	55	45

When these various points are joined to each other a figure similar to that in the accompanying diagram (Fig. 13) will be produced.

The *binocular field of vision* consists of considerable overlapping of the two fields as tested for each eye separately.

The *light sense of the periphery of the retina* may be tested by employing Holden's tests, which consist of two cards, the first having a 1 mm. black point on one side, and a 15 mm. quadrant of light gray which has four-fifths

FIG. 13.



Field of vision of right eye as projected by the patient on the inner surface of a hemisphere, the pole of which forms the object of regard (half-diagrammatic). T. Temporal. N. Nasal side. W. Boundary for white. B. For blue. R. For red. G. For green. (Landoldt.)

of the intensity of white on the other; the second card has a 3 mm. black point on one side, and a gray patch which has three-fifths the intensity of white on the other. These are approached from the periphery to the centre of the perimetric arc, and with a normal eye the black point and the gray patch of the first card should be seen out-

ward 45°, upward 30°, inward 35°, and downward 35°. The point and gray patch on the second card should be seen outward 70°, upward 45°, inward 55°, and downward 55°.

Scotoma is a name which has been given to a defect in the visual field which is produced by some deficiency in function of the corresponding portion of the retina. There are many varieties, according to different conditions and locations. Thus a *positive scotoma* is one which is perceived by the patient, and a *negative scotoma* is one which the patient does not perceive until the examination is made leading to its discovery. An *absolute scotoma* is that variety in which all vision is lost, including perception of light, and a *relative scotoma* is one in which the perception of light is diminished. Relative scotomas are also *color scotomas,* most frequently for red and green, and represent areas in the field of vision in which colors do not appear as they do under normal conditions, for example, red sometimes appearing as a dirty brown, and green as a dull white. According to their situation and form, scotomas are *central, paracentral, ring,* and *peripheral.*

In the normal eye there is a *physiological scotoma* corresponding to the entrance of the optic nerve, which is also known as *Mariotte's blind spot.* The position of this scotoma in the field of vision is usually about 15 degrees to the temporal side of and 3 degrees below the point of fixation. This physiological scotoma may be considerably increased in size in optic neuritis.

In order to locate scotomas in the visual field it is necessary to employ the small test objects, those of 2 mm. or 2.5 mm. in diameter being preferred. These are gradually moved from the point on the perimetric arc where they are first observed toward the fixation point, the patient being requested to note any point where the object disappears or where its color changes. As soon as any such area is discovered, the boundary is mapped on the chart of the visual field.

Tension. It is important in certain conditions of the eye to note whether the tension of the eyeball has deviated from normal. This is usually tested by palpating the eyeball through the closed lid with the index fingers of each hand, the other fingers resting upon the forehead of the patient. The sensation thus obtained must be compared with an eye known to be normal, for example, the other eye of the patient, or the observer's own eye. If the tension is normal it is expressed by the sign Tn; if the tension is increased it is expressed by the signs T+?, T+1, T+2, T+3, meaning, respectively, a doubtful increase, a positive increase, a moderate increase, and an extreme hardness. If the tension is decreased it is expressed by the signs T—?, T—1, T—2, T—3, meaning, respectively, a doubtful decrease, a positive decrease, a moderate decrease, and an extreme softness of the eyeball. An instrument, known as the *tonometer*, has been devised for testing the intraocular tension, but for all practical purposes the finger tips suffice.

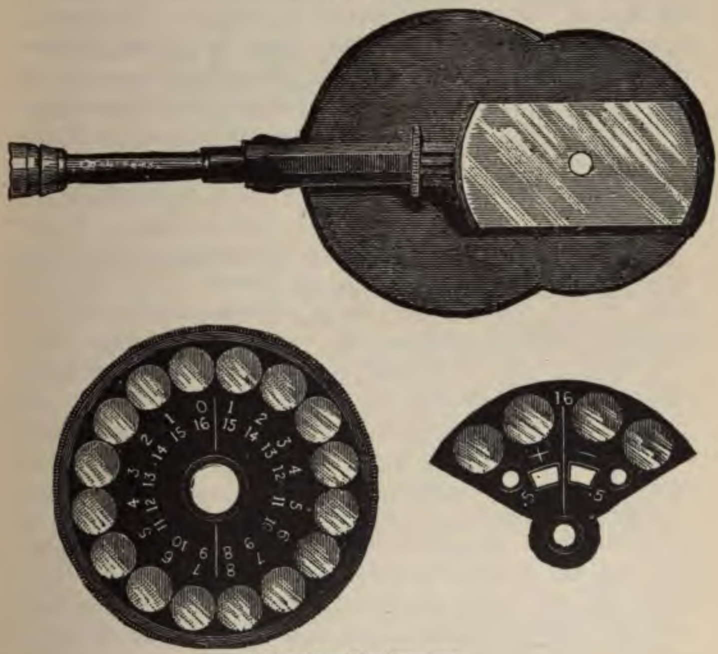
Proptosis. This is a condition in which the eyeball is being pushed from its normal position in the orbital cavity, and may be observed in various states, as in exophthalmic goitre or in paralysis of the ocular muscles. The opposite condition, that of sinking of the eyeball into the orbital cavity (*enophthalmos*), is sometimes found resulting from traumatism.

THE OPHTHALMOSCOPE.

The ophthalmoscope is an instrument which has been devised for the purpose of examining the interior of the eye, and the credit of its invention, in 1851, belongs to Helmholtz. Since the time of its invention many improvements have been made, so that at the present time it consists of a mirror perforated in its centre and so arranged that lenses of different strengths carried in a rotating disk may be aligned with the perforation. By

means of the mirror, light is reflected into the interior of the eye; a portion of it, being reflected from the retina and choroid, passes outward through the pupil of the patient and through the small central opening of the mirror, entering the observer's eye immediately behind. The mirror of the modern ophthalmoscope is usually concave,

FIG. 14.



Loring's ophthalmoscope.

with a principal focus of from 7″ to 13″, and so arranged that convex and concave lenses can be rotated into position behind the central opening while the observer is studying the conditions of the interior of the patient's eye.

There are two methods of employing the instrument, the *direct* and *indirect*.

Direct Method. For the direct method the source of light, usually an Argand burner, is placed at the side and back of the patient on a level with the eyes, the room being dark. The light is reflected into the eye by the mirror, the ophthalmoscope being held directly in front of the observer's eye. The instrument is now brought as closely as possible to the patient's eye, because the closer the observer is to the pupil of the patient the larger will be the field of vision of the interior of the eye. The rays of light thus entered spread out upon the retina, whence rays are returned, and, passing through the aperture of the ophthalmoscopic mirror, are focused on the retina of the observer, forming a virtual or upright image. If the view of the interior of the eye is not clear, that lens must be rotated in front of the observer's eye, with which the clearest image can be obtained.[1]

In making an ophthalmoscopic examination the patient must not look into the mirror, as gazing at an object so near the eye would cause the pupil to contract, and thus prevent a distinct image of the fundus from being seen. The right eye of the patient should be examined with the right eye of the observer, the ophthalmoscope held in the right hand, and *vice versa*, the patient looking with the unobserved eye at some point in the distance in order to relax the accommodation.

Indirect Method. In this method a biconvex lens of 14 D. to 18 D. strength is interposed between the patient's eye and the ophthalmoscope, the position of the light being the same as in the direct method. The lens is held with the thumb and forefinger of one hand of the observer at its focal distance from the patient's eye, the fingers resting against the patient's forehead. The light from the ophthalmoscope, which is held 12″ or 14″ distant, with a +4 D. or +5 D. lens behind the mirror to place the accommodation at rest, is reflected into the eye through the lens held in the other hand, and the distance of the

[1] The optical properties of lenses are discussed in Chapter XVII.

ophthalmoscope from the patient's eye is increased or diminished until details of the fundus are distinctly seen. The rays returning from the eye re-enter the lens and are focused at a point corresponding to the principal focal point of the lens, producing an aerial inverted image seen by the observer. Different portions of the fundus may be examined by shifting the position of the lens. When this method is being employed the patient should look at the ear of the observer.

Determination of Refraction by the Direct Method. If the eyes of both the patient and the observer are emmetropic, and the accommodation is relaxed, or at rest, in each, a clear picture of the fundus of the patient's eye will be seen by the observer. If hyperopia exists, the fundus may also remain clear, but the addition of a convex lens rotated in front of the eye will render its image more distinct, and such lenses should be brought into position until the image of the fundus begins to blur, when the lens then in front of the eye will represent approximately the amount of hyperopia. If myopia exists, a clear image of the fundus of the eye will not be obtained unless concave lenses are placed behind the aperture in the ophthalmoscope mirror of sufficient strength to render parallel the rays of light that emerge from the eye of the patient. The weakest concave lens with which a clear image of the fundus is seen is approximately the degree of myopia present.

In determining the refraction of the eye with the ophthalmoscope, some small vessel near the macular region, or the stippled appearance of the fundus in the region of the posterior pole of the eye, should be selected as the object of which to obtain a clear and distinct image. If astigmatism is present the small vessels in one meridian will be seen to be more distinct than those of a similar size passing at right angles. The strongest convex or the weakest concave lens with which the vessels in the meridians of greatest and least curvature can be distinctly seen indicates the refraction of these two meridians, and

the difference between the glasses required for the two principal meridians indicates the degree of astigmatism.

In all these examinations the accommodation of both patient and observer must be relaxed, and the observer's refractive error, if there is any, should be corrected. In estimating the amount of shortening or lengthening of the eyeball, approximately, 3 D. equals 1 mm.

Determination of Refraction by the Indirect Method. This method is employed but little in determining the degree of ametropia present, because it cannot be depended upon to furnish satisfactory estimates, and is not practical. *The presence of astigmatism may be ascertained* by this method in noting the character of the optic disk. In non-astigmatic eyes the shape of the disk does not change as the biconvex lens is moved to and fro in front of the eye; in astigmatic eyes the shape does change with movement of the lens, the disk narrowing in the meridian of least refraction and widening in the meridian of greatest refraction as the lens is withdrawn from the eye.

The Media. In beginning an ophthalmoscopic examination the conditions of the different media of the eye should be carefully determined. (See Plate I.) The cornea, aqueous humor, iris, and anterior portion of the lens may be examined by means of a +7 D. lens placed behind the aperture in the mirror, the light being reflected into the eye and the ophthalmoscope held by the observer at the focal distance of this lens from the patient's eye. The cornea, iris, lens capsule, and anterior portion of the lens are thus magnified, and any abnormal conditions may be observed. In studying the condition of the vitreous, that lens should be employed first with which the observer can see most distinctly the ocular fundus. With this lens he can observe the posterior layers of the vitreous, and, by gradually adding to this convex lenses of various strength, all the layers of the vitreous can be examined. For examinations of the most anterior layers, and for the posterior portion of the

PLATE II.

Normal eyeground (average tint).

lens, a convex lens of 12 D. to 16 D. is usually required, depending, of course, largely upon the depth of the anterior chamber. If the vitreous contains numerous opacities, these may be freely observed by reflecting the light into the eye from the ophthalmoscopic mirror, the ophthalmoscope being held about 30 cm. from the eye, and the patient instructed to move the eye in various directions. If the vitreous is fluid in character the opacities can be seen to move with the movements of the eye Opacities of the cornea, the anterior and posterior portions of the lens, may also be determined by means of their parallactic movement in relation to the border of the pupil.

The Fundus. After studying the condition of the media and the action of light upon the pupil, the next step in the examination with the ophthalmoscope is to note the details of the fundus. That glass must be rotated in front of the eye with which the observer can see most distinctly.

Optic Nerve. The first portion of the fundus to be observed is the entrance of the optic nerve. (See Plate II.) This appears as a round or somewhat oval disk, of a pinkish-gray color if normal; if congested it is naturally much redder in appearance, and in anæmia, or atrophy, is much whiter. If oval, the vertical diameter is, as a rule, the longer. There is usually a slight difference between the color of the two halves of the surface of the disk, the nasal being somewhat more pink than the temporal half. In the neighborhood of the centre of the disk is a depression known as the *physiological cup*, from which the vessels emerge. In some eyes at the bottom of the physiological cup can be seen a grayish network, known as the *lamina cribrosa.* The physiological cup is funnel-shaped, the apex of the funnel being its lowest portion. It may, however, present clean-cut edges, but these do not extend to the margins of the disk. In some instances, instead of being located near the centre of the disk, it may extend somewhat to one side. In the *glaucomatous cup* the nasal side of the disk is in-

volved and at times obliterated, and there is a distinct undermining at the edge of the disk, so that the vessels dip abruptly over it and reappear at the bottom. In absolute glaucoma this cupping usually involves the whole disk. The cup of *optic nerve atrophy* occupies the whole surface of the disk, and is shallow; there are in addition the other symptoms which accompany this condition.

If the disk is swollen the edges are indistinct, the surface irregular, and in marked papillitis the position of the disk can only be determined by the convergence of the bloodvessels. The different degrees of swelling must be studied by interposing in front of the eye those lenses of the ophthalmoscope with which each particular part is most distinctly seen. At the outer margin of the disk, in some cases, can be noted a *scleral ring*, wholly or partly surrounding the disk. Frequently at the outer side of the scleral ring is found the edge of the choroid, or the *choroidal ring*. In glaucoma the edge of the disk is often surrounded by a ring of choroidal atrophy. From the centre of the disk *the retinal bloodvessels* can be seen to emerge and to divide into two trunks, viz., the superior and inferior retinal artery and vein. Each of these again subdivide, forming the superior nasal and superior temporal, the inferior nasal and inferior temporal artery and vein. These again subdivide until the arteries finally end in capillaries accompanied by small veins. The superior and inferior macular arteries, accompanied by veins, leave the disk at the temporal side and pass toward the macular region. The superior and inferior median vessels pass outward from the nasal side.

The arteries may be distinguished by their bright red color, well-defined edges, and central whitish streak. They are also smaller and less tortuous than the veins. The veins are dark, and spontaneous pulsation is frequently noted in normal eyes (about 60 per cent. of all cases). Occasionally there emerges from the surface of the disk a so-called *cilio-retinal artery*, which is a misplaced ciliary artery (about 14 per cent. of all cases).

PLATE III.

Normal eyeground (brunette).

The Retina. The retina is perfectly transparent in nearly all its parts, and the reflex obtained by looking into the eye with the ophthalmoscope is derived from other tissues. The bloodvessels belonging to it can be seen passing through it anterior to the choroid. About one-and-one-half diameters of the disk to the temporal side and on a level with its lower third may be found the *fovea centralis,* which is occasionally surrounded by a whitish ring or reflex. In the condition of hyperopia there is frequently noted a bright sheen about the vessels, the so-called "shot-silk appearance." In brunettes the fundus is dark, of a reddish-brown color, on account of the presence of retinal pigment; in blondes the fundus is light, and, on account of the comparative absence of so much retinal pigment, the choroidal vessels can frequently be plainly seen. (See Plate III.)

FIG. 15.

Normal eyeground of albino. (Würdemann.)

The Choroid must also be studied by the use of the ophthalmoscope. The reddish reflex which is seen when making an ophthalmoscopic examination is produced by the reflection of light from the chorio-capillaris of the choroid, the pigment layer of the retina, and the pigment

cells distributed throughout the choroid. The mottled appearance of the fundus, which is more marked in the brunette than in the blonde, is due to the presence of pigment in the spaces between the choroidal vessels. In the blonde the large vessels of the lamina suprachoroideæ are visible, and the fundus is of a pale pink hue. In the brunette the color is deeper, and in the negro it becomes very dark, and in some cases is of a slate color. In the albino the bloodvessels of the choroid can be distinctly seen, and the shining through of the white sclerotic gives the fundus a very light pink tone (Fig. 15). The fundus of the eye appears paler in proportion to the light that is reflected on it; as a consequence if the examination is made when the pupil is small or the illumination weak, a darker background is observed than is the case in the same eye when the pupil is large or illumination is intense.

CHAPTER II.

DISEASES OF THE LIDS.

Erysipelas. Erysipelas seldom occurs as a primary affection of the lids, but usually spreads to them from a similar condition upon the face. There is danger of infection of the orbital tissues, with marked swelling, which may be so great as to produce sufficient pressure upon the optic nerve and central vessels as to lead to blindness. The symptoms and treatment do not differ from the same condition as when it appears elsewhere.

Eczema is seldom seen affecting the eyelid alone, but more frequently is associated with the same condition on other parts of the face. Sometimes the acrid secretions from a prolonged inflammation of the conjunctiva produce this condition. It occurs most frequently in badly nourished children whose hygienic surroundings are poor.

Treatment. The cause must, of course, be eliminated. Locally, the parts may be cleansed with a mild non-irritant soap and warm water, and, after a thorough drying, oxide of zinc ointment may be applied. It is sometimes more beneficial to add a small amount of calomel. If the condition is slow in healing the eczematous patches may be stimulated by applications of a 5 per cent. silver nitrate solution. Aristol ointment (gr. xv–℥j) has also proved of service. Constitutional remedies must not be forgotten, and quinine, iron, and strychnine are highly recommended. Fowler's solution of arsenic is employed in chronic cases. The diet must be regulated, the bowels must be kept active, and good hygiene and fresh air must be insisted upon.

Exanthematous Eruptions. Occasionally during the course of some of the eruptive fevers, eruptions appear

on the surface of the lids. They are characterized by slight redness or small pimples. Vaccine vesicles are occasionally seen, and always occur as a result of accidental inoculation. The most frequent seat is near the margin of the lid. Beyond leaving a cicatrix, which occasionally destroys the eyelashes, no harm results.

Treatment. Keep the parts as clean as possible and irrigate the conjunctiva with a solution of boric acid to reduce any accompanying inflammation of this membrane. A warm chlorate of potash lotion (gr. v–℥j) is a good application for the vaccine inflammation (Swanzy).

Toxic Dermatitis (Rhus Poisoning). In this affection, which is produced by the poison ivy or poison oak, there may be a violent inflammation of the skin of the lids. In most instances it occurs by direct contact with the poisonous substance, but in susceptible individuals it may even occur from being in the immediate neighborhood with it. The condition is usually seen in the spring and early summer, and, as a rule, is not confined to the lids The swelling of the latter, however, may be so great as to close them. There are some itching and burning, and numerous small vesicles are seen upon the surface of the skin.

Treatment. The treatment consists of protection of the affected surface and the application of soothing lotions.

Herpes Zoster Ophthalmicus is an affection which attacks the skin of the eyelids, nose, cheek, upper lip, and the side of the scalp, following the course of the first, and more rarely of the second, division of the trigeminus nerve. It is characterized by the appearance of small vesicles, which are preceded by severe neuralgic pain over the affected area. The vesicles are first filled with a clear liquid, but later become purulent, and are succeeded by the formation of crusts. If these are removed, shallow ulcers are found beneath them. As a rule, each vesicle is the seat of a small cicatrix. Occasionally the cornea itself may become affected, and ulcers are formed which may result in permanent opacities.

Even the deeper structures of the eyes may become involved, and thereby complicate the disease, if the facial branch is affected. Very rarely atrophy of the optic nerves, paralysis of some of the ocular muscles, or even a destructive inflammation of the whole interior of the eye may follow. The affection must be differentiated from erysipelas, which may be done by the severe neuralgic pain and the appearance of the vesicles following the course of the nerves above referred to. It is more frequently seen in elderly people than young adults and children.

FIG. 16.

Herpes zoster ophthalmicus. (Reeve.)

Treatment. The course of the disease is acute, and tends to recovery in two or three weeks. If the pain is very severe some of the coal-tar derivatives, like phenacetine or antipyrine, may be administered. If these are not sufficient to give relief, opium in some form will have to be employed. The nutrition of the patient must be improved by the administration of quinine and iron, and local applications of lead-water and laudanum, or weak carbolic acid lotions, will be found soothing and agreeable. If the deeper structures of the eye should become affected

the treatment should be that given under these conditions elsewhere.

Syphilis of the Eyelids. This disease, though comparatively rare, is occasionally met with. It may appear in the form of an indurated chancre, or as a secondary or tertiary sore. The chancre is of very rare occurrence on the surface of the lids, and when seen is usually found near the margin, at the inner or outer canthus. It begins as a small pimple, which soon ulcerates and becomes indurated about its base, and does not differ from the primary sore elsewhere. It is always followed by the constitutional symptoms of syphilis, and very seldom produces any permanent damage to the lids. A kiss from a syphilitic mouth, and the rubbing of the lids with a dirty finger, are the most frequent means of infection. Gumma of the lid does not differ from gumma of other parts of the body, and, as a rule, is accompanied with little pain. The history of the case and the disappearance of the swelling under antisyphilitic treatment will assist in making the diagnosis, if there is any doubt. Tertiary sores are of infrequent occurrence, but occasionally form near the free margin of the lids, and extend rapidly. Like tertiary sores in other portions of the body, they have ulcerated surfaces with indurated bases, and produce rapid destruction of the tissue involved. The diagnosis must depend largely upon the history of the case and the effect produced by antisyphilitic remedies.

Treatment. In the primary sore, applications of sublimed calomel or of the lotio nigra, or dusting with pulverized iodide of mercury, will usually bring about its disappearance. As soon as the diagnosis of the disease has become positive, antisyphilitic treatment should be instituted.

Ephidrosis is an affection of the lids characterized by excessive secretion of the sweat glands. As a rule, it is associated with excessive sweating of other portions of the body, and may produce excoriations of the skin of the lids. The cause is not known.

Treatment. The treatment must consist of soothing applications to the excoriations of the skin.

Chromidrosis is characterized by the appearance of colored secretions upon the skin surface of the lids. It is usually bluish-black in appearance and is most frequently met with in hysterical patients, although occasionally it is believed to be genuine.

Treatment. The treatment consists of relieving any constitutional diathesis which may be present and in the removal of the secretion by the application of some oily substance.

Phthiriasis (Blepharitis Pediculosa). This is an affection somewhat resembling blepharitis, and is due to the appearance of the crab-louse on the margins of the lids and on the eyelashes. They can be distinctly seen, and are usually transferred to the lid margins from other portions of the body.

Treatment. The treatment consists in the local applications of mercurial ointment, which quickly destroys both the lice and their ova.

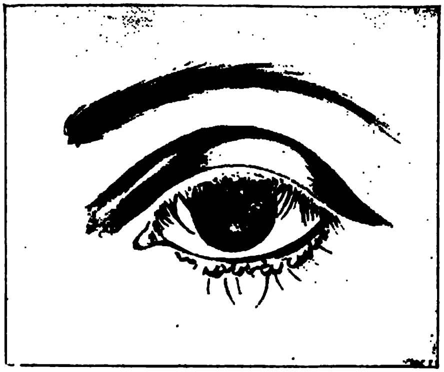
Blepharitis is a term which may be applied to any inflammation of the lids. As employed, however, it usually refers to inflammatory affections of the lid margins, and is known as *blepharitis marginalis, blepharitis ciliaris, blepharitis ulcerosa, blepharoadenitis,* etc.

Etiology. The affection usually occurs in childhood, and is more frequently seen in patients living amidst poor hygienic surroundings and having scrofulous diatheses. It may also be produced by the constant presence of irritating substances on the lid margins, by uncleanliness and chronic conjunctivitis, and is frequently found in association with nasopharyngeal disease. Errors of refraction, while not producing the affection itself, bring about congestion of the lid margins, thus making them more liable to inflammatory attacks.

Symptoms. In the *non-ulcerative* variety there is usually more or less irritation of the eyes, considerable redness at the lid margins, and in the majority of cases

the formation of small scales at the roots of the cilia. There is excessive lacrymation and slight photophobia at times. In the *ulcerative* variety the redness of the lid margins is more intense, and there is considerable secretion produced by the irritation of the hair follicles and associated glands, which, together with the conjunctival secretion, dries on the margins of the lids, producing yellowish crusts which are difficult to remove, and which cause the eyelashes to become glued together. After these crusts are removed small ulcers are found beneath them. The lids are frequently agglutinated, especially in the mornings, and the cilia become distorted and fall out. If the lacrymal punctum is everted there is also epiphoria.

FIG. 17.



Blepharitis. (Dalrymple.)

Treatment. The most important feature in the treatment of blepharitis is cleanliness and good hygiene. The crusts must be removed by means of some alkaline solution, and for this purpose castile soap and hot water are very good remedies. After making some soapsuds the crusts should be removed by careful scrubbing of the lid margins with a clean cloth or pledget of absorbent cotton. The parts are then thoroughly dried, and an application

of some stimulating ointment is made to the inflamed surface. In the milder form the application of an ointment of the yellow oxide of mercury in white petrolatum as a vehicle (gr. iv or viii–℥j) will usually effect a cure. Resorcin or sulphur ointment (gr. xv–℥j) is recommended in the severe varieties. Should the ulcers be sluggish in healing, topical applications of a sòlution of nitrate of silver (gr. x–℥j), protargol (20 per cent.), or corrosive sublimate in glycerine (1 : 200), have been found efficient. All local applications should be made at least once or twice a day.

Constitutional remedies, such as iron, quinine, and strychnine, should be administered if the patient is debilitated, and, if at all strumous, cod-liver oil, together with iodide of iron or syrup of hydriodic acid, is called for. Any existing refractive error must be corrected, irritating occupations must be changed, and any nasopharyngeal disease must be removed.

Abscess of the lids is occasionally seen, and may occur in any portion of them. It is most frequently due to injury or orbital disease.

Treatment. As soon as observed, heat should be applied, either by means of hot fomentations, or small poultices covering only the affected part, and when the abscess is found to be pointing should be freely opened and the cavity cleansed with a solution of corrosive sublimate (1 : 3000).

Hordeolum (Stye). This is a term which is usually employed to describe a painful localized swelling occurring at the margin of the lid. Styes are very apt to occur in successive crops, and produce considerable tenderness, with circumscribed swelling which soon points at the lid margin. Occasionally, at first, there may be considerable swelling of the entire lid. There is lacrymation, photophobia, and inability to use the eyes in the more severe cases. The pain, which is very great in some cases, increases with the formation of pus, and does not subside until after the stye has ruptured.

Causes. In all probability most styes are due to an acute inflammation of a hair follicle and the surrounding tissue, which generally ends in suppuration. Constitutional diathesis, eyestrain, and nasopharyngeal disease undoubtedly are contributing causes. They are also apt to occur in people exposed to the wind, or to irritating substances.

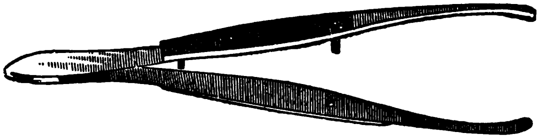
Treatment. If the patient is seen early, before actual suppuration has taken place, a stye can sometimes be *aborted* by local applications of ethereal collodion, or by the application of extreme heat or extreme cold. If suppuration has already begun, hot fomentations should be used for ten minutes every two or three hours. If there is sufficient room for the application of a small poultice without closing the eye, one made of flaxseed may be employed. The cilium should be removed from the affected follicle, and as soon as the presence of pus at the affected point is discovered a free incision should be made through the lid margin, and the pus thoroughly evacuated. The use of hot fomentations, or frequent bathing with a solution of warm boric acid, will be sufficient to produce a cure. Constitutional treatment must not be overlooked, refractive errors must be corrected, irritating substances must be avoided, and any nasopharyngeal disease, anæmia, and debility must be treated. Locally, the application of an ointment of yellow oxide of mercury (gr. viij–℥j) to the lid margins, night and morning, and internally the administration of 5 or 10 grains of calcium chloride four times a day, will greatly assist in preventing recurrences.

Trichiasis; Distichiasis. Ordinarily the cilia sweep outward in a graceful curve, and the term *trichiasis* is employed to express that condition in which a part or all of them are curved inward toward the eyeball. ***Distichiasis*** is a condition in which there are supernumerary rows of lashes, in whole or in part, and in which the inner rows turn toward the eyeball, while the other cilia are normally curved outward.

Causes. Rarely the incurving of the lashes is a congenital condition, but most frequently it arises as a result of inflammatory changes in the lids, especially those changes which are due to the cicatrization of the conjunctiva produced by granular lids. The condition may also result from traumatism.

Treatment. If the incurving lashes are few in number the condition may be corrected by the frequent removal of them by means of the cilia forceps. *Electrolysis* is sometimes employed, with good results, but is quite painful. If used, a needle attached to the negative pole of a battery is introduced through the lid margin into the follicle of the affected cilia, the other pole being held in the hand or placed at the back of the neck, and the current

FIG. 18.



Cilia forceps.

turned on. As soon as the circuit is closed a few bubbles appear around the needle, after which the cilium is readily removed. Injections of cocaine (2 per cent.) have been advocated to prevent the pain.

If, however, there are many misplaced cilia, some operative procedure to change the direction of their growth is usually required, and one of the simplest for the purpose, to produce temporary results, is *Burrow's operation.*

Burrow's Operation. This consists in everting the lid and dividing the tarsus completely through from the conjunctival to the skin surface. The incision extends from the inner to the outer canthus, and is about 2 mm. back of the lid margin and parallel to it. It can be best performed by making the opening through the conjunctiva and tarsus by means of a small knife, and finishing the

incision with the aid of a grooved director, though a pair of small curved scissors will answer the purpose very well. A probe must be passed along the line of incision daily for a short time to break up adhesions.

Hotz's Operation. Another operation which has proved efficient, not only for temporary but for permanent results, is one suggested by Hotz, of Chicago. In this the lid border is split by an intermarginal incision extending from the inner to the outer canthus, the cilia being retained in the outer portion. A transverse incision is now made through the skin of the lid and the orbicularis muscle just below, and parallel with, the upper border of the tarsal cartilage. The small band of muscular fibres covering the upper portion of the tarsus are dissected out, and the opening closed by three or four sutures which pass through the upper border of the cartilage. By this means the outer edge of the lid, which contains the cilia, is thoroughly everted, and the intermarginal incision is converted into a deep grooved wound. This groove is then filled by a wedge-shaped skin graft, taken from the skin behind the ear, as this contains no hair. It should be sufficiently long to fill the opening, and about 2 mm. in width. The graft is gently pressed into the groove and a compress bandage applied. It has been advised to keep the new lid border covered with vaseline for a couple of weeks, as the epidermis of the graft is repeatedly shed.

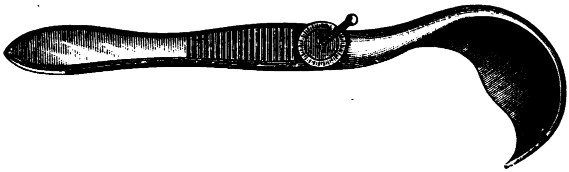
A temporary turning-out of the misplaced cilia of the lower lid may be obtained by making a slight *cauterization* from the inner to the outer canthus, about 2 mm. from, and parallel to, the lid margin, by means of a sharpened stick of caustic potash, as suggested by Theobald.

Entropion is that condition in which there is not only incurving of the eyelashes, but also of the margin of the lid itself. It is very often associated with trichiasis, and results from the same conditions as the latter. *Spastic entropion* is a form sometimes met with in old people, always affects the lower lid, and is due to overaction of

the orbicularis muscle on account of some reflex irritation. Occasionally it is seen following operations, and is a very annoying complication.

Treatment. Spastic entropion may sometimes be corrected by an application of a strip of adhesive plaster so applied beneath the eye as to draw the edge of the lid outward. The same result may be obtained under certain circumstances by painting the lid with collodion. If these measures fail, it may be corrected by the removal of an elliptical piece of skin and underlying connective tissue, the long axis of which is placed at right angles to the margin of the lid, the opening being closed with three or four sutures.

FIG. 19.



Entropion forceps.

In organic entropion some one of the various operations that have been advocated must be employed for its relief. Burrow's operation (see Trichiasis) is of temporary service.

Streatfeild-Snellen Operation. The Streatfeild-Snellen operation is popular, and is performed as follows: The globe is protected by the introduction of a horn spoon, or of entropion forceps, beneath the lid. An incision is made through the skin and muscle of the lid, parallel to the lid margin, and about 2 mm. therefrom. An elliptical-shaped piece of the skin, from 1 to 2 mm. in width, including the underlying connective tissue and muscle, is then dissected out. A wedge-shaped piece of the tarsus, having its base outward, and extending the length of the incision, is also removed, and the wound closed by three sutures, which are passed in the following manner: At the margin of the lid the needle is passed through the

skin and underlying loose tissues, carried to the upper margin of the wedge-shaped depression in the tarsus, where it includes the superficial layers of the tarsus, and is brought out without piercing the integument of the upper margin of the wound. It is then brought downward in the above manner reversed to the margin of the lid, where it pierces the skin and is tied. This procedure is sufficient to draw the lower margin of the wound of the lid upward and attach it to the tarsus, thus producing eversion of the lid margin with its cilia.

FIG. 20.

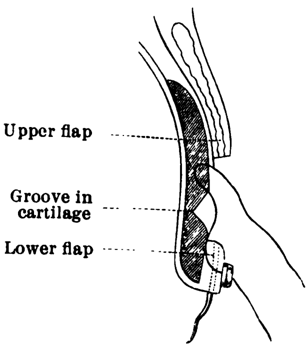
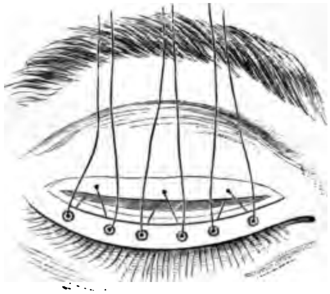


FIG. 21.



The Streatfeild-Snellen operation for entropion. (Juler.)

The Hotz-Anagnostakis operation is performed in the following manner: A curved incision, following the upper border of the tarsus, is made through the skin and subcutaneous tissue of the lid from the inner to the outer canthus, the middle of the curve being 6 to 8 mm. above the middle of the lid margin, and each end about 2 mm. above the canthus. The lips of the wound are now well separated, and the bundle of muscle fibres running transversely along the upper border of the tarsus are excised. Three or four sutures are now inserted, and each includes, respectively, the skin of the lower lip of the wound, the upper border of the tarsus, and the skin of the upper lip of the wound. These are usually sufficient to establish

firm union of the parts and to draw the lid margin upward; but in very severe cases, in addition, the intermarginal transplantation of a skin graft may have to be made (see Treatment of Trichiasis), or a canthotomy performed.

Ectropion is that condition of the lid in which the margin is turned outward and the conjunctival surface exposed. It may be either *partial*, *complete*, *spasmodic*, or *organic*.

Causes. The *organic* variety is produced by injuries of various kinds, of which burns are, perhaps, the most frequent. These destroy the skin of the lids and produce ectropion by the consequent cicatricial contraction. It is

FIG. 22.

Double cicatricial ectropion. (Reeve.)

also brought about by chronic inflammations of the lids and the underlying bones, and the condition is also observed in moderate degree as the result of paralysis of the facial nerve.

Spasmodic ectropion is usually seen in children during some acute inflammation, associated with considerable blepharospasm.

Treatment. In the mild cases, due to inflammation and hypertrophy of the conjunctiva, the condition may be corrected by painting the surface with a solution of nitrate of silver (gr. x-℥j), the application being repeated from day to day, and the excess neutralized by irrigations with normal saline solution. A properly applied bandage,

placed in position after the lid margin has been turned inward, will sometimes relieve the spasmodic form. In marked cases some form of operative procedure must be employed.

Adams' Operation. In ectropion of the lower lid, in which there is some elongation of the margin of the lid and atony of the adjacent skin, a wedge-shaped piece of tissue, having its base at the margin of the lid and its apex at the bottom of the conjunctival sac and the integument below, may be removed, and the opposing margins of the wound brought together with strong sutures. The operation is usually successful in this class of cases.

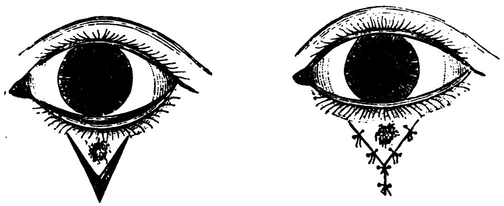
FIG. 23.

Adams' operation for ectropion. (Meyer.)

In *extensive* ectropion skin grafting is usually required. The lid is dissected free from its attachments and fixed in position by attaching it to the margin of the fellow lid. The wound thus resulting is covered with flaps of skin either taken from adjacent parts, to which they are attached by a pedicle, or from remote parts, after the manner of Wolfe. In making Wolfe's grafts the whole thickness of the skin is taken, and the piece to be grafted should be at least a third larger than the surface to be covered, as there is always considerable contraction.

Wharton Jones' Operation. Wharton Jones' method consists of making two convergent incisions, one beginning near the inner angle and the other near the outer angle of the eye, and having them meet on the cheek or forehead beyond the cicatrix producing the ectropion. The V-shaped flap of skin thus formed is then carefully dissected upward from the apex toward the base, and all adhesions which would prevent free movement of the flap completely divided. The lid margin is now restored to its normal position, and the skin along the margins of the incisions so undermined as to promote coaptation without much tension. The lips of the wound are then sutured in the form of the letter Y, as shown in Fig. 24. This operation is particularly applicable to the lower lid.

FIG. 24.



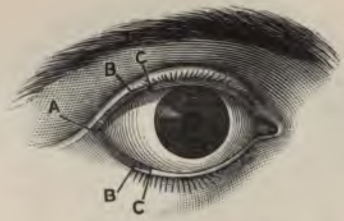
V Y operation. (From Ritterich.)

Lagophthalmos is a term employed to describe that condition in which there is inability to close the eyes by complete approximation of the lids. It is found in paralysis of the facial nerve, or may be due to exophthalmos on account of goitre, orbital tumors, or staphyloma. On account of misplacement of the lacrymal punctum there is more or less epiphora. There is also danger to the cornea on account of its exposure to the air and from foreign substances not being removed by the act of winking, although in attempting the latter act the eye usually turns up sufficiently to secure protection.

Treatment. If the condition is due to paralysis of the facial nerve, this paralysis must be removed before a

cure can be effected. The eye should be cleansed by frequent irrigations with a boric acid solution (gr. x–℥j), and should be covered when there is undue exposure to irritating substances. If the eyelid does not sufficiently protect the cornea from injury it is sometimes advisable to perform the operation of *tarsorrhaphy*. This consists in uniting the margins of the lids at the external angle in order to reduce the size of the palpebral fissure. It is better to mark with an aniline pencil the line of incision before beginning, so that an exact amount of denudation of the surface can be made. A horn spatula is introduced beneath the lids at the outer angle, and a small flap removed from the margin of each, *which must contain the*

FIG. 25.



Tarsorrhaphy. (Meyer.)

hair follicles (Fig. 25). Still firmer union may be obtained by producing slight denudation of the lid margins for a short distance beyond the flap, but care must be taken not to injure the cilia. The raw edges are then approximated by silk sutures.

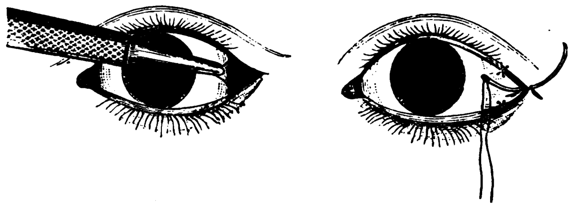
Symblepharon is an adhesion between the eyelid and the eyeball, and usually results from a burn, especially from hot metal, lime, acid, or other escharotic. It is also sometimes produced by granular conjunctivitis and by some of the operations performed for this condition. Following the treatment for any burn it is important, in addition to the use of the remedies to be described hereafter, to pass a probe between the eyelid and the eyeball daily, to break down any adhesions that may form.

Treatment. This consists in dividing the adhesions and introducing between the raw surfaces some protection until they shall have sufficiently healed to prevent their reunion. For this purpose the ordinary protective is frequently employed, and some surgeons advocate the use of a shell moulded to suit the individual case. Skin and mucous membrane grafting are sometimes used with success.

Ankyloblepharon is that condition in which the edges of the lids are united at a point somewhere between their extremities. It sometimes follows burns or other injuries, and is usually relieved by simple division of the adhesions.

Blepharophimosis is a condition in which the palpebral fissure is diminished in size on account of adhesion between the lids at the outer canthus. It may be congenital, or it may occur after ulceration or cicatricial contraction following granular conjunctivitis.

FIG. 26.



Canthoplasty. (From Ritterich.)

Treatment. The condition may be removed by the operation of *canthoplasty,* which is performed in the following manner: A horn spatula is introduced beneath the lids at the outer angle, and an incision made with a pair of straight scissors or with a scalpel, directly outward in the median line. The length of the incision should be sufficient to increase the size of the palpebral fissure as much as is desired. It is well to mark the line of incision with an aniline pencil after measuring the palpebral fissure of the opposite eye. The conjunctiva is next carefully dis-

sected loose from the skin surface and reunited to the new lid margin by three silk sutures, the outer being placed exactly in the median line at the angle of the lids (Fig. 26). *Canthotomy* is sometimes performed to enlarge the palpebral fissure temporarily and to prevent the upper lid from pressing upon the cornea. It consists simply in dividing the external canthus as above described, either with scissors or a sharp scalpel. No sutures are introduced. If it is desired at a subsequent time to correct the effect of a canthotomy or canthoplasty, it may be readily done by the operation of *tarsorrhaphy*.

Blepharospasm is that condition in which there are involuntary closures of the lids due to a contraction of part or whole of the orbicularis palpebrarum muscle. These contractions may be of a clonic nature when they occur frequently and in rapid succession, or a tonic nature when the muscle remains contracted for some time without relaxation. It may be very severe in character, producing not only a great deal of annoyance, but even injury to the sight, or it may be that there is only an annoying twitching of a few fibres of the muscle, especially in the lower lid. Sometimes children are seen who are affected with slight blepharospasm, accompanied by slight twitching of the muscles of the face, and to this condition the name of *habit chorea* has been given by S. Weir Mitchell.

Causes. The causes of this condition, if clonic spasm, are errors of refraction, prolonged use of the eyes, a debilitated condition of the patient, and mild chorea; in tonic spasm, foreign bodies in the eye, blepharitis, inflammatory conditions of the cornea or conjunctiva, and injuries to the eye.

Treatment. Whenever practicable the cause must be removed and the debilitated condition improved by the use of suitable tonics. Refractive errors, including insufficiencies of the external ocular muscles, must be corrected. In mild cases the internal administration of Fowler's solution of arsenic in ascending doses, and in the more severe cases the administration of the fluid extract

of gelsemium, will frequently afford relief. In *tonic* spasm it may be even necessary to divide the outer canthus in order to remove the pressure of the lids from the cornea.

Ptosis is a condition in which the upper lid is drooping so as to cover the eyeball in whole or in part, and in which there is not enough power to raise it sufficiently to open the palpebral fissure to the normal extent.

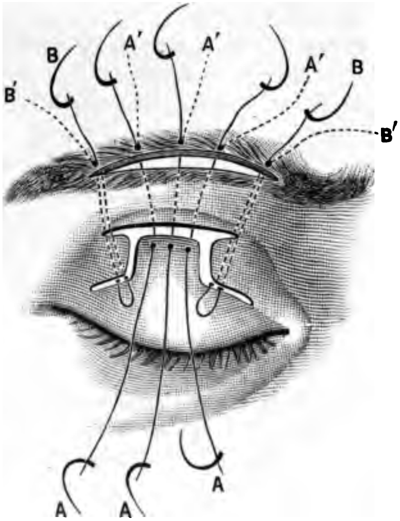
Causes. It may be due to nuclear or peripheral paralysis of the oculomotor nerve. If this is the case there is usually some other evidence of paralysis of this nerve. Hysteria and traumatism may produce the condition, or it may be acquired by hypertrophy of the lid or surrounding parts. Ptosis is sometimes congenital and associated with epicanthus or paralysis of some of the external ocular muscles, especially the superior rectus.

Treatment. If the ptosis is paralytic in character the cause of the paralysis must be removed if possible. If it is found to be syphilitic or rheumatic, the administration of antisyphilitic or antirheumatic remedies is demanded. The treatment for paralysis of the other ocular muscles must be instituted, and if, after several months, the paralyzed muscle does not regain any power, operative interference is called for, unless the uncovering of the eye will produce diplopia.

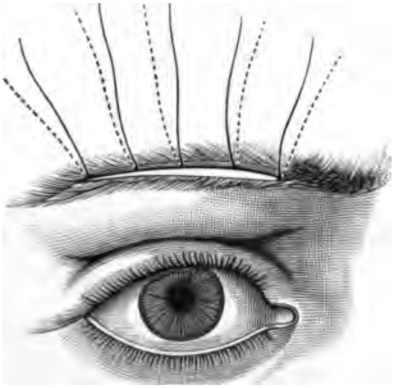
Many operations have been suggested for this condition, the simplest form of which consists in the removal of an elliptical piece of skin, with the underlying muscle, from the upper lid and bringing the edges of the wound together with a few sutures.

Pagenstecher's operation is applicable to most forms of ptoses, is frequently efficient, and is performed as follows: A suture is passed through the skin about 2 cm. from the ciliary margin at the centre of the lid, and continued subcutaneously to the ciliary margin; a loop is then made by passing the suture upward again and bringing it out on the surface of the skin near the point at which it was entered. The ends of the suture are then tied, and tight-

FIG. 27.



Panas' operation. A, A′. Central sutures. B, B′. Lateral sutures. (Nettleship.)



Panas' operation (after). (Nettleship.)

ened daily until the suture has cut through the tissues. The object of the operation is to form a cicatricial band subcutaneously from the margin of the lid to the inferior portion of the occipitofrontalis muscle, which, according to Pagenstecher, is usually sufficient to relieve the condition. As many bands as may be necessary to accomplish this result are formed in the manner described.

Panas' Operation. An incision, a little less than an inch in length, is made through the lid at the orbital margin. A second, somewhat longer incision, parallel to the first, is then made slightly above the eyebrow down to the periosteum. The bridge of skin and muscle thus formed is freed from the underlying tissue. A flap of skin and muscle of the shape shown in the accompanying diagram (Fig. 27) is now dissected from the tarsus as far as its lower border without disturbing the suspensory ligament, and then drawn beneath the bridge of tissue and fastened to the upper lip of the upper incision by three sutures. It is frequently necessary to add two lateral sutures to prevent ectropion.

TUMORS AND HYPERTROPHIES.

Many varieties of tumors and hypertrophies are found in the eyelids as well as in other portions of the body. Among these are the following:

Xanthelasma is a condition characterized by the appearance of a number of buff-colored patches upon the skin of the lids which are slightly raised above the surface. Their location is most frequently upon the upper lid near the inner canthus. They are extremely irregular in shape, usually occur in advanced life, and microscopically consist of numerous granular cells, some of which are pigmented and located in the skin. They are only annoying because of their appearance.

Treatment. The patches may be readily removed by dissection, if desired, unless this would be so extensive as to produce distortion of the lids or cilia.

Milium is a term which is applied to the appearance of very small whitish elevations, about the size of a pin's head, sometimes found upon the surface of the skin of the lids. They are small retention tumors of the sebaceous glands which often develop about the age of puberty, and are frequently caused by improper care of the skin.

Treatment. Each elevation may be readily removed by puncture with a small knife.

Molluscum Contagiosum. This condition is an affection of the sebaceous glands, in which the glands and ducts become greatly hypertrophied and form rounded elevations on the lids, which appear more frequently on the lower lid near the nose. Their size varies from a few millimetres in diameter to that of a centimetre, although the smaller ones are by far the more frequent. They are of a waxy color, and in the centre of the top of each there is a whitish point, which marks the opening to the duct of the involved gland, and from which a cheesy material may be forced by pressing.

Causes. The growths are believed to be mildly contagious, and are probably due to a degeneration of the epithelium cells brought about by the contagion, the nature of which is unknown.

Treatment. Each molluscum should be split from base to apex and the contents completely removed; or the entire growth may be excised.

Chalazion (Meibomian Cyst, Tarsal Tumor). A chalazion is a small cyst or tumor, due to an inflammation of a Meibomian gland and the tissue which surrounds it. By some it is supposed to be an aborted hordeolum. They begin by the retention of the glandular secretion, which is followed by inflammation of the surrounding tissue, and vary in size from a few millimetres to that of a centimetre in diameter, or even larger. They may point outward beneath the skin, or inward beneath the conjunctiva, and are acute or chronic according to the rapidity with which they develop. The growth is benign in character, and, like styes, there is a marked tendency to recur in crops.

Cause. The definite cause is unknown.

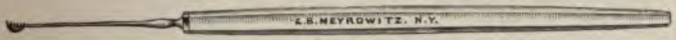
Treatment. The lid should be everted, if the chalazion is small, and an incision made with a sharp knife on the surface of the conjunctiva where the cyst is observed to be pointing. A small chalazion curette is next intro-

FIG. 28.

Chalazion. (Reeve.)

duced into the interior of the sac, and the contents, as well as the sac wall, are thoroughly scraped out. If the chalazion is large, a lid clamp may be placed upon the lid and the growth dissected out from the outer surface. To prevent recurrence, or to remove small inflammatory

FIG. 29.



Skeel's chalazion curette

deposits which may lead ultimately to the formation of chalazia, massage with an ointment of the yellow oxide of mercury (gr. viii–℥j) is sometimes employed. A small portion of the ointment, about as large as a split pea, is placed beneath the conjunctival surface of the lid, and

massage performed for a few moments by carefully rubbing the outer surface. The suppurating form of chalazion must be treated by hot fomentations and free incision and evacuation as soon as pus is discovered.

Papillomata and **Cutaneous Corns** are occasionally observed in the lids. The papillomata are hypertrophied papillæ of the skin, and cutaneous corns are connective tissue new-growths.

Treatment. The treatment consists of complete removal, either by dissection or by the application of a caustic, if this may be employed without injury to the eye.

Small *pearly cysts* are occasionally seen on the lid margin, and sometimes give rise to irritation. They may be removed by puncture.

Lipoma, Neuroma, and **Fibroma** are sometimes found in the lids, but do not differ from these conditions occurring elsewhere. They should be removed by careful dissection.

Cavernoma, Angioma, Nævus. *Cavernoma* is a vascular growth composed of anastomosing spaces resembling dilated veins which occurs in the connective tissue structure of the lids, and which originates primarily in the lids, or is an extension of the same growth from adjacent portions of the face. It is occasionally congenital, and has a tendency to increase in size. An *angioma* is a somewhat similar growth, which is due to dilatation of capillaries and small arteries. A *nævus* is a slightly elevated patch, congenital in nature, occasionally found on the surface of the lids. It is usually pigmented.

Treatment. When a nævus is discovered in a newborn child, and is small in size, it may be easily removed by the careful application of an escharotic, for example, nitromuriatic acid. Vaccination of these tumors has also been suggested as a means of securing their removal. If large, they may be removed by the ligature, the galvanocautery, or electrolysis. For cavernoma or angioma the best plan of treatment is complete extirpation by careful dissection. Treatment by electrolysis has been advocated,

but the author has not seen satisfactory results follow its use in the case of large growths. If employed, multiple punctures with the needle should be made around the base of the tumor, with the object of destroying the blood supply.

Sarcoma. *Primary sarcoma* of the eyelid is comparatively rare, but may occur at any age, on either lid, and vary in size from that of a pinhead to that of an apple. It is found somewhat more frequently in females than in males.

Treatment. Complete extirpation should be performed as early as possible.

Carcinoma may appear either as a *rodent ulcer* or as an *epithelioma.* If it appears as a rodent ulcer the ulcerative process is slow, and there is little tendency to involvement of the neighboring lymphatic glands. If it appears as an epithelioma, it usually begins at the margin of the lid, advances slowly, and, if not checked, usually progresses to complete destruction of the lids and deeper structures, and eventually ends in the death of the patient. Like epithelioma elsewhere, a lid epithelioma is composed of epithelial cells which have become perverted in their growth and location.

Symptoms. The presence of a small pimple situated on the margin of the lid, usually accompanied by slight redness and covered with a scab, is the first that the patient notices of the affection. It may result from a small papilloma which takes on an ulcerative change. The scab covering the ulcerated surface is frequently removed, but the ulcer does not heal. This condition may continue for months, or years, but sooner or later it gradually extends to the adjacent parts, when the patient is subject to frequent sharp pains, becoming greater as the deeper structures are involved.

Treatment. Numerous methods of treatment of this condition have been advocated. The use of escharotics, in the form of a chloride of zinc paste, or the actual cautery, have been employed, with more or less success. Frequent applications of trichloracetic acid to the edge of the carcinomatous growth is advocated by some surgeons.

The general consensus of opinion, however, is that early excision, as complete as possible, supplemented by the use of the actual cautery or of a solution of chloride of zinc in those cases in which all of the diseased tissue cannot be successfully removed, is the best treatment. In the later stages, complete exenteration of the orbit may be required.

Lupus Vulgaris of the eyelids does not differ in any way from the disease as it appears upon other portions of the face and requires no special description here. It should be borne in mind, however, in considering syphilis and epithelioma, for which it might be mistaken.

CONGENITAL DEFECTS.

Congenital defects are met with in the eyelids as well as in other portions of the body.

Epicanthus is one of the most frequent, and consists of a continuation of the skin from the side of the nose directly outward, so that each inner canthus is partially or wholly covered. It gives the appearance of a very flat nose and an unusually small palpebral fissure.

Treatment. The condition is most frequently bilateral, and is best corrected by removing an elliptical shape piece of the integument from the bridge of the nose with the long axis vertical, and approximating the edges. This operation should not be performed in very young children, in whom the condition is occasionally seen in slight degree, and which is due to a flattened nasal bridge that frequently disappears as the child becomes older.

Ptosis as a congenital condition is occasionally observed, and has been referred to in another part of this chapter.

Exceedingly rare congenital anomalies are *ablepharia*, or absence of the eyelids; *cryptophthalmos*, or absence of the eyelid and conjunctiva, but in which condition the eyeball is concealed by the skin; *symblepharon*, *ankyloblepharon*, *ectropion*, *entropion*, and *distichiasis*. The treatment of these conditions has been described elsewhere.

CHAPTER III.

DISEASES OF THE LACRYMAL APPARATUS.

THE diseases of the lacrymal apparatus may be separated into two portions, viz., those affecting the gland, and those affecting the drainage apparatus.

DISEASES OF THE GLAND.

Dacryoadenitis is an inflammation of the lacrymal gland that is very infrequently observed. It may be acute or chronic, suppurative or non-suppurative. The latter variety has sometimes been known as mumps of the lacrymal gland.

Causes. The cause of dacryoadenitis is probably of an infectious nature. The entrance of dust into the conjunctival sac carrying with it infectious material which makes its way into the lacrymal ducts, must be considered as one of the factors in the production of this affection. Exposure to cold and traumatism are also causes to be considered.

Symptoms. Dacryoadenitis manifests itself by a swelling at the outer angle of the lids, with more or less redness of the outer portion of the conjunctiva. There is slight pain, usually referable to the temple. The affection is of sudden onset, and usually reaches its height in two or three days. It frequently ends in suppuration, and the inflammation rapidly subsides upon the evacuation of pus, terminating its course in from a week to ten days. The superior portion of the lacrymal gland is seldom affected. The disease is rare, and may be recognized, in addition to the symptoms described, by the presence of a hard swelling at the outer orbital margin in the position of the lacrymal gland, which can be detected by palpation.

If the patient is made to turn the eye forcibly toward the nose a portion of the gland is thus pushed forward and may be observed.

Treatment. Hot fomentations should be employed early to encourage the formation of pus. If pus is present, free evacuation, by opening from the conjunctival surface, is advisable. If the gland should become hard, the internal administration of the iodide of potassium or sodium and careful massage of the parts by means of the yellow oxide of mercury ointment are to be employed.

Hypertrophy of the Lacrymal Gland is very infrequent, and when not congenital may be due to syphilitic or sarcomatous degeneration. Occasionally the hypertrophy is so large as to produce displacement of the eyeball, with all the accompanying symptoms.

Treatment. The treatment consists in the administration of antisyphilitic remedies if there is the slightest suspicion of syphilitic infection, and, this failing, complete extirpation of the gland before it has reached sufficient size to damage the eyeball.

Atrophy of the Lacrymal Gland has been observed in xerophthalmia. The functional activity of the gland may be abolished in paralysis of the trigeminal nerve.

Dacryops is an affection in which there is a cystic distention of one of the ducts of the gland which makes its appearance as a bluish swelling beneath the conjunctiva at the outer upper portion.

Treatment. The treatment consists in puncturing the cyst, thus allowing it to collapse.

Dacryoliths are chalky concretions which are infrequently met with in the lacrymal gland, and are apt to produce mechanical irritation. They may be removed by incisions through the conjunctiva.

Dislocation of the Lacrymal Gland sometimes occurs spontaneously, and also as the result of injury.

Treatment. The treatment consists in restoration of the gland to its normal position, if possible, and the application of a compress bandage in order to prevent a re-

dislocation. If reduction cannot be performed, it may be necessary to extirpate the gland.

Fistula of the Lacrymal Gland. When this condition is not congenital it is usually due to traumatism, and the tears exude on the surface of the brow or cheek from the fistulous opening.

Treatment. The fistula may be closed by an application of the actual cautery. The passage of a seton from the gland to the conjunctival surface has also been advised.

Tumors of the Lacrymal Gland. The lacrymal gland may be the seat of numerous new-growths, among which are *adenoma, angioma, epithelioma, endothelioma, osteochondroma* and *sarcoma.* When present, as a rule, they may be felt under the upper outer angle of the orbit as a firm mass. They may attain considerable size, compress the tissues in the immediate vicinity, and push the eyeball out of its natural position in the orbit.

Treatment. The treatment should be total extirpation at the earliest possible moment.

DISEASES OF THE DRAINAGE APPARATUS.

Epiphora is a term usually employed to describe the escape of tears from the conjunctival sac over the cheek, and is a symptom of most of the affections of the lacrymal drainage apparatus, probably mechanical in origin.

Reflex epiphora, or excessive lacrymation, however, sometimes occurs as a result of irritation, either in the lacrymal passages themselves or in the nose.

Malpositions of the Puncta are occasionally seen, more frequently in the lower than in the upper lid, and may be due to an atonic condition of the lids such as is sometimes seen in old people, to injury, or to facial paralysis. The puncta instead of lying in contact with the eyeball, as they do normally, are everted, and epiphora results.

Treatment. The treatment consists in bringing about the approximation of the punctum to the eyeball by what-

ever means possible according to the cause of the condition, and, failing in this, the canaliculus may be slit so as to make a larger opening to permit the tears to enter the lacrymal sacs more easily.

Atresia (Closure) of the Lacrymal Puncta is a condition infrequently observed, but may arise from traumatism to the parts. If the canaliculus is found to be normal the punctum should be opened and kept so by the frequent passage of small probes.

Atresia (Closure) of the Canaliculi may occur as a result of inflammatory processes which are most frequently catarrhal in nature, and which have resulted by extension from the lacrymal sac or from the conjunctiva. The condition may also be caused by calcareous deposits, by growths, such as polypi, or by foreign bodies, such as eyelashes or a beard of wheat. *Dacryoliths*, consisting of a calcified fungus (leptothrix), have also been observed in this condition.

Treatment. If there is acute inflammatory swelling, it should be reduced by treatment of the conjunctiva and lacrymal sac, which are always involved. Strictures are dilated by the passage of small probes, which are gradually increased in size. Foreign bodies must be extracted by opening the canaliculus.

Dacryocystitis is a term which is applied to inflammation of the lacrymal sac, and may be either *acute* or *chronic* in character.

Acute Dacryocystitis, sometimes known as *abscess of the lacrymal sac*, presents the following symptoms: Epiphora is always present because of the closure of the drainage apparatus, and also, perhaps, on account of excessive secretion of tears due to reflex disturbance. This condition may have been present to a greater or lesser extent for some time. There may have existed, previous to the acute inflammatory attack, a slight swelling over the region of the sac, which, when pressed upon, would cause some mucus to exude through the lacrymal puncta or into the nose. The onset of the acute variety is usually accompanied by considerable pain in the region of the sac, and

PLATE IV.

Phlegmonous dacryocystitis.

marked swelling and redness of the surrounding parts. Palpation will usually disclose the presence of an oblong, hard tumor at the inner canthus, which, upon pressure, may evacuate pus into the conjunctival sac or nasal cavity. The redness sometimes becomes excessive, looking not unlike erysipelas, from which it must be differentiated (Plate IV.); and on account of the closure of the nasal duct and canaliculi the pus cannot escape, and the abscess opens itself externally.

Causes. The causes which produce this condition are catarrhal inflammation of the lining membrane of the sac, and occasionally necrosis of the lacrymal bone. The entrance and retention in the lacrymal sac of pyogenic organisms produce an inflammation which soon becomes purulent. The contents of the sac form a suitable medium in which the micro-organisms can readily grow. These

FIG. 30.

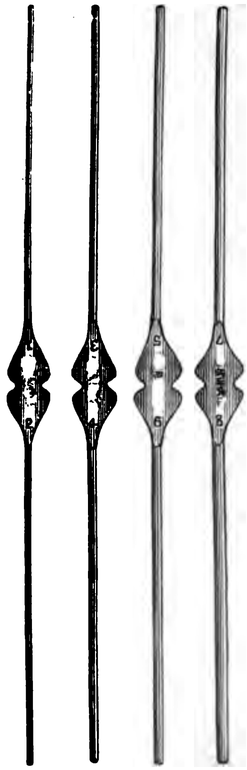
Weber's canaliculus knife.

influences are brought about, as a rule, through the medium of the nasal duct to the lacrymal sac, the condition spreading from a catarrhal affection of the mucous membrane of the nose. It is exceedingly rare for disease of the conjunctiva to produce this inflammation of the lacrymal sac. Stricture of the nasal duct follows the catarrhal inflammation, causing the retention of tears in the sac and preventing their escape, thus permitting them in a short time to become suitable soil for the growth of the various micro-organisms. An hypertrophied condition of the sac is sometimes brought about in the progress of the disease, and the formation of polypi is noted.

Treatment. If the patient is seen early before the lacrymal abscess is pointing, it may be possible to effect drainage into the nose by slitting the canaliculus and by the passage of probes.

Method of Slitting the Canaliculus In performing this operation, a knife devised by Weber for the purpose is to be recommended. Standing behind the patient for operation upon the right lower canaliculus, the thumb of the

FIG. 31.



Bowman's probes.

left hand is placed upon the outer third of the lower lid and pressed downward and outward so that the lacrymal punctum may be everted from the eyeball. The probe point of the knife held in the right hand, with the cutting

edge upward, is now passed through the lacrymal punctum directly inward and upward along the canaliculus until it is felt to press upon the mucous membrane over the lacrymal bone. The blade of the knife is then turned slightly backward so that the slit to be made will lie in juxtaposition to the eyeball, and with a sweep of the knife upward through a quadrant of a circle, the centre of which is the point resting upon the mucous membrane of the lacrymal bone, the lid being held taut during the whole procedure, the upper portion of the canaliculus is thoroughly opened.

FIG. 32.

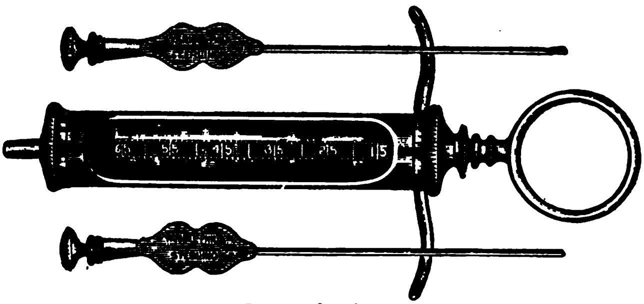
Bowman's probes in position. (Reeve.)

Some surgeons advise the opening of the canaliculus by means of a different knife which is placed in a position corresponding with the axis of the nasal duct and pushed downward into the duct three or four times, thus freely dividing all existing strictures. After the canaliculus has been opened and the knife withdrawn, probes are passed through the lacrymal sac into the nasal duct, thus effecting free drainage of the pus below. The probes ordinarily employed vary in size from No. 1 to No. 15, but it is not frequently necessary to pass a larger one than No. 6

(Bowman), and this size is only reached after gradual dilatation has been employed for several days. The entrance of the probe is effected in the same manner as the knife for dividing the strictures.

Method of Passing Lacrymal Probes. Standing behind the patient, with the lid drawn downward and outward by the thumb of the left hand, if the probe is to be passed in the right duct, it is entered into the canaliculus and passed inward, upward, and backward until it is felt to rest in contact with the mucous membrane of the lacrymal bone. Holding the point in this position, and taking care that it does not slip outward, it is rotated upward through a quadrant of a circle and

FIG. 33.



Lacrymal syringe.

placed in the axis of the nasal duct, when it slips through the lacrymal sac and nasal duct into the inferior meatus of the nose. If there is doubt as to its position, it may be readily determined by reflecting light into the nose with an ordinary head mirror.

After the probes have been passed and effective drainage obtained, the lacrymal sac is next irrigated, by means of a lacrymal syringe, with some mild antiseptic and astringent solution. For this purpose a tepid solution of boric acid (gr. x–℥j) or a solution of bichloride of mercury (1 : 5000) may be employed. If the latter is used, great

care must be taken to prevent the solution from running into the throat, which may be done by having the patient place his chin upon his chest, thus throwing his nose forward while the irrigations are being made. If the formation of pus continues for some time, a weak solution of nitrate of silver (gr. iij to v–℥j) or a solution of zinc sulphate (gr. v–℥j) may be employed.

If *the abscess is pointing externally* at the time when first seen, which is more frequently the case, it should be lanced in the line of the face. A probe is then passed through the opening thus made into the nasal duct and drainage effected into the nose. Irrigations with the solutions above described are next employed, or, according to some surgeons, the sac is packed with narrow strips of iodoform gauze. As soon as the acute swelling has sufficiently subsided, however, the canaliculus should be slit, probes passed and irrigation employed from above so that the unnatural opening may be permitted to heal, if possible, without the formation of a fistula. In addition, hot fomentations, supporting remedies, and the internal administration of some form of iron, preferably Basham's mixture, are valuable adjuncts in the management of the disease.

Chronic Dacryocystitis is that condition of the lacrymal sac in which there is more or less constant epiphora, accompanied by the formation of a mucocele on account of distention of the sac. Pressure over the region of the sac will usually produce exudation of mucus or muco-pus through the lacrymal puncta into the conjunctival sac. The latter is frequently inflamed because of the presence of the irritating secretion.

Causes. The causes of this condition are usually a catarrhal inflammation of the lining membrane of the drainage apparatus extending from the nares. There is almost always one or more strictures of some portion of the duct, the points of preference being the junction of the canaliculus with the lacrymal sac, and the junction of the lacrymal sac with the nasal duct. The disease may

also be produced by closure of the entrance of the nasal duct into the inferior meatus on account of an inflammatory condition of the surrounding portions of the nose, hypertrophy of the inferior turbinate bone, or adhesions.

Treatment. If pus is present, there is invariably one or more strictures within the duct, and the treatment should consist of slitting the canaliculus, gradual dilatation of the strictures by means of probes, and irrigations of the sac by means of antiseptic and astringent solutions. At first probes should be passed daily, and the frequency gradually diminished until they are passed at occasional intervals only. After the operation of slitting the canaliculus has been performed, the patient must be directed to place his finger upon the inner corner of the lid and draw open the cut surfaces several times daily to prevent their reunion. Some surgeons open the upper canaliculus and a few open both, although the operation upon the lower is sufficient in most cases. Lacrymal *styles*, or *canulæ*, are occasionally inserted into the duct for temporary or permanent use.

In those cases of chronic dacryocystitis in which constant and prolonged treatment has failed to produce any permanent relief, *excision of the lacrymal sac*, or its destruction by means of caustics, has been advocated. This may be accompanied by *extirpation of the lacrymal gland* to prevent the excessive formation of tears. These are radical measures, however, which have to be employed but rarely.

Epiphora is occasionally observed in cases in which no mucus can be expressed from the lacrymal sac. In many of these the strictures are purely functional in character, and it would be manifestly improper to adopt the same severe operative procedures required in strictures of the organic variety.

Treatment. In this class of cases a moderate dilatation of the lacrymal punctum by means of a small lacrymal dilator, and irrigations with a tepid boric acid solution, or a solution of hydrochlorate of cocaine (2 per cent.) or adrenalin chloride (1-10,000), followed by the warm boric

acid solution, will frequently effect a cure of the condition.

Congenital Anomalies of the lacrymal apparatus are infrequently met with, but the following conditions have been recorded: There may be *absence of the lacrymal puncta and canaliculi,* or they may be *double.* *Fistula of the lacrymal gland* has also been recorded as a congenital defect. In this condition the fistulous opening has been observed in the outer third of the upper lid. It may be closed by repeated cauterization. *Congenital hypertrophy of the gland* is also infrequently observed.

CHAPTER IV.

DISEASES OF THE CONJUNCTIVA.

Hyperæmia of the Conjunctiva (Dry Catarrh). In hyperæmia of the conjunctiva there is moderate injection of the bloodvessels, especially those of the palpebral conjunctiva, there being a persistent redness of this portion of the membrane.

Causes. The principal causes are uncorrected, or improperly corrected, refractive error; exposure to irritating substances, such as dust, tobacco smoke, and strong wind; exposure to excessive light, or employment of the eyes with improper illumination; excessive use of alcoholic beverages; a rheumatic diathesis; vasomotor disturbances, and disease of the nares.

Treatment. The cause should be ascertained and removed, and the conjunctiva should be freely irrigated with a solution of boric acid several times a day. In persistent cases, douching the closed eyelids three or four times daily with extremely hot or cold water is of use. This may be accomplished by means of a fountain syringe with a numerously perforated nozzle hung about two feet above the head. The douching may be made a little more agreeable and stimulating, if desired, by adding a teaspoonful of alcohol or cologne water to the hot or cold water. If the hyperæmia is of vasomotor origin, the administration of the tincture of nux vomica and the fluid extract of ergot will assist in relieving the condition.

Acute Catarrhal Conjunctivitis (Simple Conjunctivitis, Mucopurulent Conjunctivitis). Acute catarrhal conjunctivitis is the mildest form of inflammation with which the conjunctiva is affected. It is simply a swelling of the conjunctiva and a production of conjunctival dis-

charge in addition to the hyperæmia previously described. There may be slight photophobia and sufficient discharge to produce an agglutination of the lids in the mornings, and there is always a sensation as if a foreign body were located beneath the lid and scratching upon the eyeball. The disease may be limited to one eye, but usually both become affected before relief is obtained. There is a general hyperæmia of both ocular and palpebral conjunctivæ, the former less marked in the neighborhood of the cornea.

Causes. The chief causes are exposure to cold, the presence of small foreign bodies, infection from some other case, and exanthematous fevers.

Treatment. In the treatment of acute catarrhal conjunctivitis it is necessary to remove any cause that is instrumental in its production. Careful search should be made for minute foreign bodies, and the nares should be examined for any affection of these parts. The conjunctiva should be thoroughly irrigated every few hours with some cleansing antiseptic solution. Solutions of boric acid (gr. x–℥j), physiological salt solution, solutions of bichloride of mercury (1 : 6000), or solutions of formaldehyde (1 : 4000), may be employed for this purpose. If the discharge persists after the use of these irrigations the lids should be everted and the conjunctiva painted with a solution of nitrate of silver (gr. v–℥j) once a day, and the excess neutralized with a saline solution. A solution of protargol (20 per cent.) is also very effective in this class of cases.

Acute Contagious Conjunctivitis ("Pink Eye," Epidemic Conjunctival Catarrh). **Symptoms.** The patient at first experiences a burning beneath the lids and a sensation of the presence of a foreign body. This is rapidly followed by lacrymation and the production of a mucoid secretion. In twenty-four to forty-eight hours this secretion becomes mucopurulent, and the conjunctiva is swollen and the lids more or less puffed. With the progress of the disease there is greater annoyance to the patient, and some photophobia is experienced. In severe cases small

hemorrhages appear beneath the conjunctiva, which is deeply injected. Occasionally the ocular conjunctiva is chemotic. The lids are glued together, and the discharge, which is more or less stringy in character, re-forms within a few minutes after its removal. Occasionally false membranes are observed on the conjunctival surface. The affection usually runs its course in from ten days to two weeks, but in exceptional instances it may continue for several months. It affects adults worse than children, and small phlyctenules sometimes appear as a complication.

Causes. Probably the most frequent cause of this affection is a small bacillus (the *Koch-Weeks bacillus*) which was discovered independently by Koch and Weeks. It remained, however, for Weeks to study carefully its morphology. It is a small, straight bacillus, measuring 0.25 μ in width, and from 1 to 2 μ in length, and grows in agar at a temperature ranging between 85° and 110° F., its inoculation into the normal conjunctival sac from a pure culture invariably producing the disease. The disease is communicated through the secretion of the eyes of patients who are affected with it.

Another form of conjunctivitis from which it has thus far been impossible to distinguish it clinically is produced by the *pneumococcus of Fränkel*. Like the acute contagious conjunctivitis just described, this form also appears in epidemics, is virulently contagious, and may affect persons of any age. It may also be transferred from the eyes of one patient to those of another, and, as a rule, the second eye becomes affected within twenty-four to forty-eight hours after the appearance of the disease.

Treatment. If the affection is severe and accompanied by much swelling of the lids, great relief can be obtained by the application of cold compresses. Irrigation of the conjunctiva every fifteen minutes, half hour, or hour, according to the frequency with which the discharge re-forms, with some cleansing solution, is called for. Solutions of the zinc preparations seem to give the best results.

Sulphate or the chloride of zinc in the strength of from ½ to 2 grains to the ounce, employed at frequent intervals, usually brings about a rapid diminution of the discharge. As soon as the disease becomes mucopurulent in character, the topical application to the everted conjunctiva of a solution of nitrate of silver (gr. v to x–℥j), protargol (20 per cent.), or argyrol (20 per cent.) is called for. If any complications should arise, the treatment must conform to that particular complication. The presence of false membranes on the conjunctiva does not call for any change in the plan of treatment, except, perhaps, the more cautious application of the solution of nitrate of silver. If there is much dread of light during the progress of the disease the eyes should be protected from bright light by the use of smoked glasses.

Purulent Conjunctivitis. This variety of conjunctivitis is one of the most severe forms of inflammation with which the conjunctiva may become affected. The term is employed to designate the gonorrhœal form of conjunctivitis, which is usually known as conjunctivitis neonatorum in the infant, and as gonorrhœal conjunctivitis in the adult.

Conjunctivitis Neonatorum (Ophthalmia Neonatorum). **Symptoms.** This variety of inflammation usually begins in from two to three days after birth. The lids may be slightly or enormously swollen, the skin red, their edges agglutinated, particularly in the mornings, and after the stage of hyperæmia has passed there appears a thick, purulent secretion which escapes from between them when they are separated. At first there is very little pain; but as the disease progresses the conjunctiva and lids become more swollen and the discharge more copious and thinner. The child loses its appetite, is restless, and apparently suffers considerable pain. The disease gradually declines, and in from six weeks to two months the discharge ceases. There may appear a haziness of the cornea, followed by ulceration and perforation which frequently result in total destruction of the cornea and escape of the lens, followed by shrinking of the globe and loss of vision. It

is this corneal complication which is the chief danger to be feared during the progress of the disease.

Causes. Two varieties of this affection are usually recognized. The first, or *specific variety*, is due to the presence in the conjunctiva of the *gonococcus of Neisser*, which was discovered in 1879, and with which the conjunctiva is inoculated during the passage of the child through the birth canal. The micro-organism is a double coccus which can be readily found in all gonorrhœal pus, and produces a virulent type of inflammation in which there is a marked tendency to invasion of the corneal tissue. The second, or *non-specific variety*, is probably due to inoculation of the conjunctiva with mucopurulent discharge other than gonorrhœal during birth. A late variety of the disease is due to inoculation after birth by the use of soiled towels, sponges, etc. Occasionally, in newborn infants there is some hyperæmia of the conjunctiva together with moderate discharge, which may be due to uncleanliness of some character, and which is not to be mistaken for the affection just described.

Prognosis. If the case is seen early before the cornea has become affected, and proper treatment is instituted, in most cases the prognosis is good. There are, however, a few cases which seem to be malignant from the beginning, in which the nutrition of the cornea becomes readily depreciated so that corneal complications, with consequent loss of visual acuity, supervenes. Statistics show that about 20 per cent. of our blind population is due to neglected cases of this disease.

Treatment. The treatment of conjunctivitis neonatorum is twofold—prophylactic and curative.

The *prophylactic* treatment consists in the employment of all antiseptic precautions during labor and in the thorough cleansing of the eyes of the infant immediately after birth. If there is no reason to suspect gonorrhœal infection of the mother, or if there has not been present a severe vaginal discharge during gestation, the eyes may be cleansed immediately after birth by wiping carefully

the lids and surrounding parts with a pledget of absorbent cotton moistened with a solution of boric acid, and the irrigation of the conjunctiva with a similar solution. If, however, there is the least suspicion of gonorrhœal infection, *Crédé's method* of prophylaxis should be employed. This consists in cleansing the eyes as above described, as soon as the child is born, and immediately instilling into each eye one or two drops of a 2 per cent. solution of nitrate of silver. Crédé ascertained that this practice reduced the percentage of cases of conjunctivitis neonatorum occurring in the hospital with which he was connected from 13 per cent. to less that 2 per cent. Conjunctivitis neonatorum is now recognized as the cause of so many of the blind individuals with which our asylums are filled that many States have enacted laws making it a misdemeanor for nurses and midwives not to report to the health officer the existence of red or inflamed eyes in the newborn as soon as they are observed.

The *curative* treatment consists in the constant application of cold compresses during the stage of swelling, and removal of the discharge from the conjunctiva every fifteen minutes or half hour, day and night, by irrigations with some one of the various antiseptic solutions employed for the purpose, viz., solutions of boric acid, sodium chloride, corrosive sublimate, formaldehyde, or permanganate of potassium. (See formulæ, Chapter XIX.) These irrigations may be made by means of an ordinary pipette, but it is better to make them with a fountain syringe, if possible. As soon as the "velvety" appearance of the conjunctiva has disappeared and the discharge has become free, the lids should be everted once a day and their conjunctival surfaces painted with a solution of nitrate of silver (gr. x to xv–℥j), the excess being neutralized by the application of a solution of sodium chloride. There may be placed in the conjunctival sac a small portion of pure vaseline to assist in the protection of the cornea. Should haziness of the cornea occur, one or two drops of a solution of atropine (gr. ii-℥j) should be instilled two or

three times a day, and the cold compresses discontinued and hot compresses employed in their place. If any complications of corneal ulceration supervene they must be treated according to the rules given under this heading. Too much stress cannot be laid upon careful, conscientious nursing in the treatment of this disease, and all hospital cases should be isolated until the gonococcus has disappeared from the conjunctival discharges.

Gonorrhœal Conjunctivitis. **Symptoms.** The symptoms of gonorrhœal conjunctivitis do not differ from those of conjunctivitis neonatorum except in their severity. As a rule, the cornea is in much greater danger of destruction than in the infant, and the affection produces a marked debilitated condition of the patient. The disease reaches its height in about ten days, and then gradually subsides, occasionally passing into a chronic variety which consists of considerable redness of the conjunctiva of the lids and some thickening of the papillæ.

Cause. The cause of the disease is the *gonococcus of Neisser*, previously referred to, with which the conjunctiva has become inoculated in some manner.

Diagnosis. It must be borne in mind that acute contagious conjunctivitis is sometimes so severe as to resemble markedly gonorrhœal conjunctivitis; therefore, a microscopic examination of the conjunctival secretion will not only be of service to the surgeon in treating the affection and an aid in prognosis, but at times of much assistance in quieting the patient's mind concerning his condition.

Treatment. The treatment of gonorrhœal ophthalmia in the adult does not differ from the treatment of a similar condition in the infant, except that more severe measures may be employed. As soon as the patient is seen, if one eye is as yet unaffected, it should be protected by means of a *Buller's shield* (Fig. 34). This consists of a watch crystal which is placed over the eye and sealed by means of adhesive plaster, or gauze covered with collodion. A good substitute is a shield of isinglass fitted to the nose,

brow, and cheek, and similarly sealed about its edges. Cold compresses constantly employed during the stage of swelling, copious irrigations with solutions of boric acid, mercuric chloride, permanganate of potassium or some other of the solutions mentioned in connection with conjunctivitis neonatorum, every fifteen minutes or half hour during the day and every two hours during the night, a

FIG. 34.

Buller's shield.

daily application to the everted lids of a solution of nitrate of silver (gr. x to xv–℥j), together with the employment of atropine (gr. iv–℥j) and the substitution of hot compresses in cases with corneal complications, will usually bring about a cure. It is exceedingly rare, however, for a case of gonorrhœal conjunctivitis to get well without some scarring of the cornea. In those severe cases in

which the lids become so tense and hard as to threaten the destruction of the cornea by their pressure, a canthotomy may be performed for the temporary relief of the condition. It is important that sustaining remedies, such as quinine, iron, and strychnine, nourishing diet, and, in some cases, a moderate amount of stimulants be administered.

Croupous Conjunctivitis (Pseudomembranous Conjunctivitis). Croupous conjunctivitis is an affection occurring in early childhood in which the palpebral conjunctiva is much swollen and covered with a false membrane, which may be easily detached, leaving a raw surface beneath which bleeds very little.

Symptoms. The disease begins as an acute catarrhal conjunctivitis in which the lids become greatly swollen and followed, in a few days, by the appearance of false membrane on the palpebral conjunctiva. This can be readily detached, but re-forms with remarkable rapidity. In a few instances ulceration of the cornea complicates the condition.

Causes. The exact cause is unknown, but staphylococci, diplococci, and occasionally streptococci, have been found in the membrane. In some of the cases in which the latter micro-organism is found there is a marked tendency to streptococcus inflammation in other portions of the body, with a corresponding grave prognosis. The disease is sometimes seen as recovery is taking place from exanthematous fevers and may occur during an attack of croupous inflammation of the respiratory tract. The affection is regarded by some surgeons as a mild diphtheria. A form of croupous conjunctivitis in which the membrane constantly re-forms, sometimes for months, is known as *recurrent croupous conjunctivitis.* Croupous conjunctivitis must be differentiated from diphtheria of the conjunctiva.

Treatment. Some form of lotion which will assist in removing the membrane, in addition to cold compresses to the lids during the stage of swelling, should be em-

ployed. An ordinary lotion of boric acid, formaldehyde, or mercuric chloride may be used, but a solution of chlorate of potassium (gr. xv–℥j), as suggested by Knapp, seems to be more effective. During the active stage of membrane formation applications of silver nitrate should not be employed, but upon the disappearance of the membrane their use may be cautiously tried.

Diphtheritic Conjunctivitis. This is a disease characterized by the formation of membrane upon the palpebral and ocular conjunctiva which is most severe in character.

Symptoms. There is enormous swelling of the eyelids, with formation of purulent or bloody discharge from the conjunctival surface. The lids become so exceedingly hard that it is almost impossible to evert them, but if this can be done there are found a number of grayish-white patches which have a tendency to coalesce and involve the whole conjunctiva of the lid. If the membrane is removed it leaves a granular, bleeding surface beneath. The affection is very apt to lead to complete destruction of the eye by sloughing of the cornea which may take place in a short time after its appearance. There are the usual constitutional disturbances of diphtheria. As the affection subsides the discharge becomes more of a purulent nature, and gradually disappears.

Cause. In the membrane there is always to be found the Klebs-Loeffler bacillus, which distinguishes it from other varieties of membranous conjunctivitis, though this micro-organism may not appear in pure culture. In suspected cases smears and culture examinations must be made at an early moment.

Treatment. From the very first, constant cold applications should be made to the eye if the cornea has not become involved. The conjunctiva must be kept as clean as possible by frequent and copious irrigations of a warm solution of boric acid, or a solution of mercuric chloride. If the cornea is threatened by severe pressure of the lid a canthotomy should be made, or, as advocated by some surgeons, the lid may even be split through its centre to

the depth of the conjunctival sac and the edges turned up to the brow. An ointment of iodoform may be placed on the conjunctiva after each irrigation to afford as much protection to the eyeball as possible. During the stage in which the membrane is present nitrate of silver, if used at all, must be employed very cautiously; as soon, however, as the swelling is reduced and the membrane disappears a very weak solution may be tried. Internally the same remedies that are used in diphtheria of the fauces must be administered. Most excellent results have been reported from the early administration hypodermically of the antitoxin of diphtheria. The other eye should be protected by means of a Buller's shield or bandage, and, if the cornea at any time becomes affected, atropine must be instilled and hot compresses employed instead of cold.

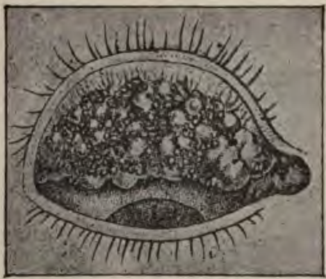
Granular Conjunctivitis (Trachoma). This is a condition in which the conjunctiva is studded with small elevations, discrete in the early stages, and coalescing with the formation of large, hard masses as the disease progresses. The lids become rough, and by rubbing against the cornea there is produced ulceration, vascularity, opacity, and in some instances complete destruction of the cornea, with loss of vision.

Causes. The disease is contagious through its secretion, affects all ages and classes, but is most frequently observed in the uncleanly and in those whose surrounding hygienic conditions are poor. It is an affection occurring in low altitudes, and the Eastern races seem to be particularly predisposed. The disease is believed to have been introduced into Europe by Napoleon's army after his Egyptian campaign. The researches of Sattler and Michell make it extremely likely that trachoma is of microbic origin, but their work has not been sufficiently corroborated to make the proof positive.

Symptoms. These vary according to the individual case. In some forms there is very little inconvenience to the patient, and he is scarcely aware of the granulations in the conjunctiva until they have fully formed and eversion of

the lid discloses the conjunctiva studded with small sago-like bodies distributed throughout its entire surface (Fig. 35). They are very apt to occur in rows parallel to the ciliary margin. In the *acute form* the disease begins as an acute conjunctivitis in which there is considerable redness and hypertrophy of the conjunctiva, moderate swelling of the lids, and a copious mucopurulent secretion. In the early stage the swelling of the conjunctiva may entirely hide the granulations, but as the disease progresses the swelling diminishes and the trachoma bodies become visible. There is much annoyance to the patient, and

FIG. 35.



Conjunctiva of upper lid in chronic granular conjunctivitis. (Arlt.)

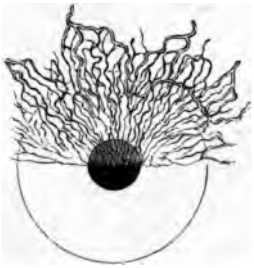
the sensation of a foreign body in the eye is always present, accompanied by some pain on account of friction against the cornea, and some swelling of the lid. In the *chronic form* in which cicatricial changes occur, the cornea is very apt to become affected and to be accompanied by superficial ulceration. There is more or less secretion, and there may be photophobia which is especially marked if the cornea is involved.

Varieties. Three forms are usually described depending on the condition of the conjunctiva, viz., the *papillary*, in which the tarsal conjunctiva has a thickened velvety appearance and upon which numerous small papillæ are seen; the *granular*, in which the conjunctiva is studded

with round or flat semitranslucent bodies (trachoma granules) arranged in parallel rows and are more numerous in the fornix; the *mixed,* in which both the papillary and granular are intermingled and by far the most common variety.

Trachoma may also be *acute* when its onset is sudden and the inflammatory symptoms marked, a condition in its early stages not unlike purulent conjunctivitis; or *chronic* when its onset is slow and insidious, the variety most frequently observed. The disease has also been divided by Knapp into *inflammatory trachoma,* when the inflammatory symptoms are prominent and there is a de-

FIG. 36.



Pannus affecting upper half of cornea. (Nettleship.)

cided tendency to the formation of cicatrices; and *non-inflammatory trachoma,* when there are few inflammatory symptoms, though the tarsal and retrotarsal conjunctiva are filled with granulations. The inflammatory variety is believed to be contagious and the non-inflammatory non-contagious.

Course. The course of trachoma is very chronic and there is very little tendency to spontaneous recovery. As the disease progresses and some of the trachoma granules disappear, various cicatricial changes take place in the conjunctiva and are productive of serious complications.

Complications and Sequelæ. As the cicatricial change is progressing, the eyelid may become more or less distorted

producing trichiasis, entropion, ectropion, or symblepharon. By constant irritation of the cornea, the latter may become more or less vascular, accompanied by superficial ulceration, a condition known as *pannus* (Fig. 36). The ulceration may be more extensive and followed by *perforation* and *staphyloma of the cornea.* The conjunctiva may undergo such extensive changes that *xerosis* (see page 106) results.

Treatment. The treatment of trachoma is twofold—medical and surgical. The *medical treatment* should be begun by keeping the eyes as clean as possible by frequent irrigations of the conjunctiva with a solution of boric acid. The conjunctival surface is stimulated by topical applications of astringents, such as a crayon of sulphate of copper, or a solution of boroglyceride (30 to 50 per cent.), or a solution of glycerine and tannin (gr. xxx to lx–℥j). If the discharge is copious, applications of nitrate of silver should be employed for a time. At first these applications may be made daily, and their frequency gradually lessened. If the cornea becomes attacked and an ulcer appears, a drop of a solution of atropine (gr. iv–℥j) should be instilled two or three times a day, and hot compresses employed; the treatment of the conjunctiva, however, is not changed. After an application of copper or nitrate of silver is made to the conjunctiva of the everted lid, the fornix being included, the excess must be washed off. In those cases in which vascular pannus has become marked and persists in spite of conjunctival applications and the use of atropine, an infusion of jequirity bean has been employed to produce a violent inflammatory condition of the conjunctiva for the purpose of curing the granulations and of clearing up the pannus. It may be used strong, a violent inflammation being produced at once, or topical applications of a weak solution may be employed, the treatment extending over a long period of time. This method of treatment is advocated, however, by comparatively few surgeons.

The *surgical treatment* of trachoma consists in the

removal of the contents of the trachoma bodies by expression or by excision. The operation of expression is best performed by means of roller forceps, those devised by Knapp, perhaps, being the most popular (Fig. 37). The operation may be performed under local anæsthesia, but is painful, and general anæsthesia should be employed. After cleansing the conjunctiva thoroughly, the lid is everted and one blade of the forceps placed on the conjunctiva which is exposed, and the other blade beneath the non-exposed conjunctiva in the fornix, when, by a stripping motion, the contents of the follicles are forced out. Care must be exercised to remove all those existing in the fornix and at the angles of the eye and at the same time to avoid tearing the conjunctiva or injuring the cornea. A moderate traumatic conjunctivitis follows the operation,

FIG. 37.

Knapp's trachoma forceps.

and should be treated by cold compresses for the swelling and a boric wash for the discharge, in addition to local applications of a weak solution of nitrate of silver once a day. After the acute inflammation subsides the topical application of some of the above described astringents should be continued. This form of treatment is applicable to the stage of trachoma in which the granulations are still discrete, especially of the non-inflammetory type. For the treatment of the second stage, a number of small horizontal and perpendicular scarifications should be made prior to the expression, and the operation followed by a brushing application of a solution of bichloride of mercury (1 : 1000 or 1 : 500). The application of some pure vaseline, or bichloride of mercury ointment, to the conjunctival sac will usually prevent the formation of any adhesions. Individual follicles may be destroyed by means

of the galvano-cautery, and electrolysis has also been advocated by some surgeons.

A *canthoplasty* to relieve the pressure of the lid upon the cornea, and *slitting the canaliculus,* together with the passage of probes so that free drainage of the secretions may be obtained, will materially assist in clearing up severe complications.

Constitutional treatment must also be employed in patients affected with this disease. Good food, pure air, and proper exercise are essential. The fact that the secretion is contagious must be borne in mind by surgeon, nurse, and those with whom the patient comes in contact. Instruction should be given concerning the individual use of towels, sponges, etc., and if there seems to be any tendency to spread among crowds, as in schools, asylums, or armies, isolation for a time is demanded.

Follicular Conjunctivitis is a non-contagious affection characterized by the appearance of a number of small, grayish-white elevations arranged for the most part in parallel rows, and found principally in the retrotarsal folds. It is seen under conditions of bad hygiene, sometimes occurring in epidemics and according to some surgeons is regarded as an early stage of trachoma. There is slight photophobia and some discharge, and upon everting the lids the enlarged follicles are distinctly observed.

Treatment. The hygienic surroundings must be improved. The secretion is eliminated by means of a boric acid lotion and topical applications of a solution of nitrate of silver, protargol, or argyrol. Applications of a solution of copper sulphate (2 per cent.), or the employment of the same drug by means of an ointment (gr. ss–℥j), have been advocated, and some cases do well from the local use of glycerol of tannin (gr. xl–℥j). All eyestrain should be removed, and in those cases in which improvement does not take place under the use of topical applications, expression with the roller forceps may be performed.

Phlyctenular Conjunctivitis. This variety of conjunctivitis is characterized by the development of small

FIG. 38.

Phlyctenular conjunctivitis. (Dalrymple.)

FIG. 39.

Phlyctenular conjunctivitis in a scrofulous subject. (Dalrymple.)

conical vesicles in the conjunctiva of the eyeball which usually occur near the corneal margin. At first they appear as red points, but soon become vascular and eventually contain pus, breaking down and forming small superficial ulcers. There is always considerable irritation of the conjunctiva in the immediate vicinity of the vesicles. If the phlyctenulæ are confined to the conjunctiva there is usually very little photophobia, but if they involve the cornea, pain and photophobia become prominent symptoms. Some discharge is always present, the lids becoming agglutinated during sleep. The phlyctenulæ are apt to appear in crops, and relapses are common.

Causes. The affection is probably the most common eye disease of children, and by some surgeons is considered analogous to eczema of the skin. It usually occurs in children of the so-called strumous diathesis, and is frequently accompanied by an eczematous eruption about the head or face. Errors of diet and bad hygiene are also contributing factors. There is almost always present a co-existing disease of the nasopharynx. The condition is dependent upon infection of the conjunctiva, the presence of the vesicles and pustules in all probability being due to the entrance of some micro-organism beneath the conjunctival epithelium, probably the staphylococcus pyogenes aureus or albus.

Treatment. The eyes must be kept clean by frequent irrigations with a solution of boric acid, and inasmuch as the disease is usually found in patients with a strumous diathesis, such remedies as will relieve this condition should be employed. Cod-liver oil, arsenic, and iron, especially in the form of the syrup of the iodide, are particularly called for. Nourishing and easily digested diet, fresh air, and good hygienic surroundings will materially assist in effecting a cure. The eating of sweets and the drinking of tea and coffee must be prohibited. The removal of any co-existing intranasal or alimentary disease is demanded, and after the acute symptoms have subsided the application of a small portion of yellow oxide

of mercury ointment beneath the palpebral conjunctiva, followed by slight rubbing of the lids, will assist in the removal of the phlyctenulæ.

Spring Conjunctivitis (Vernal Conjunctivitis, Frühjahr's Catarrh). This is a form of conjunctivitis apparently becoming more frequent, in one variety of which the cornea becomes partly or wholly surrounded by an elevated, fleshy mass, which encroaches slightly upon its margin. The elevation is usually smooth but may be nodular. It is sometimes accompanied by a roughened, granular condition of the conjunctiva of the lids, somewhat milky in appearance, and there is an absence of severe pain. Three varieties of the affection have been described: the *ocular,* affecting the limbus; the *palpebral,* affecting the conjunctiva of the lids, and the *mixed,* which affects both. The affection is very persistent, is more frequently seen in children than in adults, and may accompany an attack of "hay fever;" like the latter disease, it also has a tendency to recur about the same time in successive years. It is more apt to appear in early spring and summer, and almost entirely disappears in the winter months.

Treatment. As a rule, the treatment is unsatisfactory. The eye must be kept clean, and weak astringents may be employed both as lotions and as topical applications. Massage with yellow oxide of mercury ointment is of benefit in some cases, and in others change of climate is desirable.

Subacute Conjunctivitis (Diplobacillus Conjunctivitis). This is a variety of subacute, or at times chronic, conjunctivitis, characterized by moderate redness of the lid margins, some congestion of the conjunctiva, and very slight discharge. It is due to a diplobacillus about 1.5 μ in breadth, and 2 to 3 μ in length. They are frequently found in chains, and are sometimes described as the *diplobacilli of Morax.*

Treatment. The treatment consists in irrigating the conjunctiva several times daily with a solution of chloride

or sulphate of zinc (gr. ss to ij–℥j). Ordinary cleansing lotions do not seem to rid the conjunctiva of the micro-organism.

Parinaud's Conjunctivitis is a rare disease, so-called because it was first described by Parinaud, which consists of considerable swelling of the lids, with polypoid granulations on the conjunctiva, and involvement of the lymphatic glands. Considerable depression is observed during the course of the swelling, and its onset is usually attended with slight rigors. There is an accompanying swelling of the cervical, the submaxillary, and the preauricular glands of the affected side; occasionally these even suppurate. No specific micro-organism has been demonstrated, but the disease was attributed by Parinaud to infection of animal origin.

Treatment. If the granulations are not numerous they may be cut off and their bases cauterized. Cleansing lotions and weak astringent applications to the conjunctiva are of service. As a rule, the condition goes on slowly to recovery.

Toxic Conjunctivitis is applied to those forms of inflammation of the conjunctiva which are produced by exposure to certain toxic substances. The condition may be produced by the dust arising in the employment of certain chemicals, or by a continuous use of some of the drugs employed in the eye, for example, atropine.

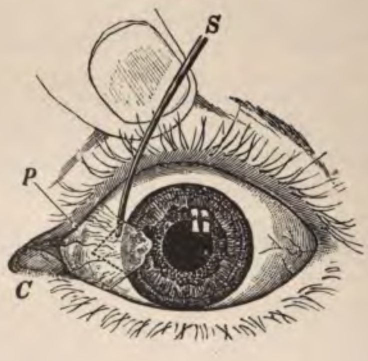
Treatment. The treatment consists in the removal of the cause, cleanliness of the conjunctiva by irrigations with a boric acid solution, and the application of a weak solution of nitrate of silver (gr. v–℥j) if there is much accompanying discharge, or the application of glycerine and tannin (gr. xxx–℥j) if there are numerous follicular granulations, as are found in atropine conjunctivitis.

Lithiasis of the Conjunctiva. These are small concretions which, upon everting the lids, are seen to lie beneath the surface of the conjunctiva. They are yellowish in color and about as large as a pinhead in size, and are produced by accumulations of calcareous deposits in

the Meibomian or in other glands of the lids. Commonly they are seen in people of a rheumatic or gouty diathesis, and produce considerable annoyance by acting much as foreign bodies in the production of slight irritation of the conjunctiva. They are readily removed by pricking each concretion with a sharp knife or needle under cocaine anæsthesia.

Pterygium is a fleshy growth probably due to long-continued irritation of that portion of the conjunctiva which is most commonly exposed, viz., the portion oppo-

FIG. 40.



Pterygium. (Fuchs.)

site the palpebral fissure. According to some surgeons it usually arises from a preceding pinguecula on the nasal side of the cornea. It consists of hypertrophy of the conjunctiva and subconjunctival tissue, and is triangular in shape, having its base toward the inner canthus and its apex toward the cornea. It may extend only to the limbus of the cornea, but frequently extends as far as the centre, and in some cases even beyond. The condition is more common in men, and is usually seen in patients who have passed middle life. *Pseudopterygium* is seen as a result of injury or disease.

Treatment. The treatment of a pterygium consists in its entire removal or in so changing the direction of its growth that it is away from the cornea rather than toward it.

Method of Excision. A number of methods are employed. One of the best is to pass a strabismus hook beneath the apex of the pterygium, after local anæsthesia, and with gentle force to tear it loose from its attachment to the cornea. This is better than dissection, and recurrence is much less apt to follow detachment by this method. Two converging cuts are then made through the base of the pterygium, having their apex pointing toward the caruncle. The conjunctiva is then slightly undermined and its edges approximated with three or four sutures. The edge of the cornea to which the pterygium was attached is gently scraped with a sharp knife,. or curette, and if, after the application of the sutures, the conjunctiva should overlap the corneal margin in the least, a short perpendicular incision is made above and below, to permit the conjunctiva to retract. A bandage should be applied and the eye dressed daily for a few days, when the sutures may be removed.

Method of Transplantation. This method is also frequently employed, especially in those cases where the removal of a pterygium by the method just described would produce exposure of too large a surface. In the method of transplantation the apex of the pterygium is again torn loose from the cornea by means of the strabismus hook, after which an incision is made through the ocular conjunctiva into the lower cul-de-sac. The point of the pterygium is then turned downward into the incision and stitched into the lower cul-de-sac, and the margins of the wound approximated. Some surgeons prefer to dissect the apex of a pterygium from the cornea rather than tear it loose with a strabismus hook.

A Pinguecula is a small, yellowish, elevated mass, appearing in the horizontal meridian of the globe on the nasal side of the cornea. It is located in the conjunctiva, is usually situated a few millimetres from the margin of

the cornea and is composed of elastic and non-elastic connective tissue. According to some surgeons it is a point from which pterygia usually grow.

Treatment. No special treatment is required except in those cases in which removal is desired for cosmetic purposes, when it may be accomplished by excision.

Amyloid Disease of the Conjunctiva. This is a rare affection of the conjunctiva which consists in the development in the conjunctival tissue of yellowish translucent swellings, the ocular conjunctiva being the first affected. The tissue gives a strong amyloid reaction to iodine and sulphuric acid and was formerly supposed to have arisen from granular conjunctivitis. It is now believed, however, that the growths are independent of this disease. The condition is local and is accompanied by no pain.

Treatment. If not too extensive, the amyloid tissue may be excised.

Xerosis of the Conjunctiva (Atrophy of the Conjunctiva, Xerophthalmos). Two varieties of this disease are described: (1) That form of dryness of the conjunctiva which results from atrophy as a sequel of trachoma, in which the cornea becomes cloudy and opaque, and vision is much interfered with. (2) A form in which complete dryness is not present. This variety appears, as a rule, in poorly-nourished individuals, and is characterized by the occurrence on the conjunctiva of whitish masses of an oleaginous nature. These patches appear in adults as small triangular masses at the margin of the cornea in the horizontal meridian, and the affection has sometimes been known as *xerosis triangularis* because of the form assumed; in infants, the masses usually appear first in the folds of the lower cul-de-sac and as the affection progresses cover the whole conjunctiva. The latter is sometimes described as *xerosis infantilis* and affects infants with marasmus, usually terminating fatally. Night-blindness is a frequent symptom of the disease in the adult.

Causes. Poor food, impure air, and other bad hygienic surroundings are factors in the production of the affection.

A bacillus has been found in the secretion which was claimed to be the pathogenic cause, but this has not been verified. It is now believed that the condition of the tissues favors the growth of this micro-organism which would not exist if the system were restored to the normal condition. The first variety is met with after granular lids, diphtheritic conjunctivitis, and essential shrinking of the conjunctiva.

Treatment. In infants treatment is of little avail. In adults, since the secretion is of an oleaginous nature, saponifying remedies may be employed to cleanse the affected portions, followed by applications of strong antiseptics. The thickened mass is scraped away, a saponifying remedy applied, and the antiseptics used subsequently. Nutritious diet and a change of air and surroundings may also assist in the recovery.

Leprosy and Lupus of the Conjunctiva are occasionally observed, but do not differ from these affections when seen in other portions of the body.

Tuberculosis of the Conjunctiva is also of very rare occurrence. It is occasionally termed *lupus* because the same micro-organism is said to be the cause of both affections. It may occur as a primary or as a secondary affection, and in the latter instance is usually seen in association with tuberculosis of the nose or throat. In the early stage isolated nodules, somewhat resembling trachoma follicles, appear, usually upon the palpebral conjunctiva, but also at times upon the ocular conjunctiva; later these break down and form superficial ulcers. The disease advances slowly.

Diagnosis. This can be determined by bacteriological examination of a portion of the diseased tissue for the tubercle bacillus.

Treatment. Excision of all or as much of the diseased tissue as possible, and the application of the galvano-cautery to any remaining portion, as soon as the diagnosis has been made. Those remedies that are employed for tubercular conditions in other portions of the body for im-

proving the nutrition of the patient must also be administered.

Abscess of the Conjunctiva is a very rare condition, in which there is a circumscribed area of suppuration in the subconjunctival tissues which should be opened, the pus freely evacuated, and cleansed several times a day with antiseptic solutions.

Syphilis of the Conjunctiva is sometimes seen in the form of a primary sore, or as secondary or tertiary ulcers, the latter being gummata which have broken down.

Treatment. The treatment consists in the local application of a cleansing lotion, stimulating astringents, and the internal administration of antisyphilitic remedies.

Lymphangiectasis of the Conjunctiva is characterized by the appearance of a number of small blisters filled with a semitransparent fluid, and usually gathered in chains. They are situated superficially on the ocular conjunctiva and move readily with the latter membrane. They are probably due to some interference with a natural flow of lymph and frequently disappear spontaneously, but if they produce annoying symptoms each blister may be evacuated by pricking.

Subconjunctival Hemorrhage usually occurs beneath the ocular conjunctiva as a result of strain in coughing, or at stool, or from some violent exercise or injury. The condition is very frequently seen during an attack of whooping-cough. There is a deep red patch beneath the conjunctiva which may partially or wholly surround the cornea. Frequently occurring subconjunctival hemorrhages are sometimes observed in nephritic disease, and whenever seen should direct attention to an examination of the urine.

Treatment. Cold compresses in the early stages to check the bleeding, and later hot applications to promote absorption, together with a cleansing wash, are all that is required locally. Subconjunctival injections of physiological salt solution seem to hasten the absorption of the hemorrhage.

Tumors and Cysts of the Conjunctiva. *Lipoma, fibroma, osteoma,* and *papilloma* are among the benign tumors sometimes found having their origin in the conjunctiva. The congenital growths observed are *angioma, dermoid cysts, translucent cysts,* and *pigment spots.* The malignant growths are *epithelioma* and *sarcoma.*

Treatment. Complete excision in the early stages, and in the later stages of malignant growths enucleation, sometimes with exenteration of the orbit.

Argyria Conjunctivæ (Argyrosis) is a brownish discoloration of the membrane produced by long-continued applications of nitrate of silver solutions. The condition cannot be removed.

Diseases of the Caruncle. **Encanthis** is the name given to that condition of the caruncle in which it is inflamed and enlarged and which may even progress to the formation of an abscess.

Trichosis Carunculæ is that condition of the caruncle in which there is excessive development of the minute hairs located there.

Various **tumors** having their origin in the caruncle have also been recorded. *Primary sarcoma* and *adenoma* have been reported by the author, and *carcinoma* of the caruncle has also been described.

Treatment. For an inflammation of this portion of the conjunctiva the application of mild astringents and soothing lotions should be employed. Tumors must be removed by excision, and if malignant, their bases cauterized.

Congenital Anomalies. Congenital defects of the conjunctiva consist of *pigment patches, dermoid tumors, telangiectatic patches,* and *cavernoma.*

CHAPTER V.

DISEASES OF THE CORNEA.

Keratitis is a term applied to any inflammatory condition of the cornea, and by most authors is divided into two general varieties, viz., the *suppurative* and *non-suppurative.*

Phlyctenular Keratitis (Superficial Keratitis, Phlyctenular Keratoconjunctivitis, Eczematous Keratitis). This affection is practically the same as that described under the name of phlyctenular conjunctivitis in discussing diseases of the conjunctiva.

Symptoms. The phlyctenulæ appear on the cornea as small, elevated vesicles, usually connected with the conjunctiva by a number of minute bloodvessels. As the disease progresses the vesicles are found to contain pus, and, breaking down, form small, superficial ulcers. The affection of the cornea is quite painful, and marked photophobia is a prominent symptom. In some of the cases, after the vesicle has broken down, another appears slightly in advance of the first, which is also connected with the periphery by a leash of small vessels. This process sometimes continues until a narrow path has been formed across the cornea. It may stop, however, at any point, but leaves a whitish line to indicate its former position. When the disease affects the conjunctiva alone it is described as *phlyctenular conjunctivitis;* when it affects the cornea as *phlyctenular keratitis;* when both cornea and conjunctiva are involved, as *phlyctenular kerato-conjunctivitis.*

Causes. The causes are the same that produce phlyctenular conjunctivitis. A scrofulous diathesis, some dis-

turbance of the alimentary canal, and disease of the naso-pharynx in early life are prominent factors in its production. It is supposed by some authors to be analogous to eczema of the skin and is called by them eczema of the cornea. The micro-organisms thus far found in the vesicles are the staphylococcus pyogenes aureus and albus.

Treatment. As it is most frequently seen in children whose general condition is much debilitated, the free

FIG. 41.

Phlyctenular keratitis. (Dalrymple.)

administration of tonics in conjunction with nourishing, simple food, pure air, and good sanitary surroundings, is called for. The conjunctiva should be freely irrigated several times daily with some cleansing lotion, such as boric acid (gr. x–℥j) and one or two drops of a solution of atropine (gr. iv–℥j) instilled at night and morning. The eyes must be protected by the use of smoked glasses, and the employment of hot compresses from five to ten

minutes several times daily will assist in the alleviation of pain and promote absorption of the vesicles. A purgative should be administered in those cases in which the alimentary canal is involved, and the use of sweets, tea, and coffee must be prohibited. As photophobia is a most prominent symptom in this affection, means must be employed for its relief. When it is found to be due to excoriation at the angles of the lids, the topical application of a solution of nitrate of silver, or of the solid stick of sulphate of copper, is of value. Forcible stretching of the eyelids, which is sometimes done in attempting to examine the condition of the eye, is also of service. In some cases of long duration the condition can be best relieved by dipping the child's face for an instant into a basin of cold water. A similar effect may be obtained in older patients by douching with cold water from a fountain syringe four or five times daily. Temporary relief can sometimes be obtained from the local use of a solution of holocaine (1 per cent.). In those cases in which the photophobia is so great as to produce a constant blepharospasm, a canthotomy or canthoplasty is required. Any abnormal condition of the nares must be carefully treated, as this frequently gives rise to the phlyctenular inflammation. The treatment of the conjunctival condition is the same as that in phlyctenular conjunctivitis.

Ulcer of the Cornea. Ulcer of the cornea is that condition in which an abrasion of the epithelial layer has been followed by infection, or in which infiltration of the corneal substance, failing to be absorbed, has broken through the overlying corneal tissue. Many varieties of corneal ulcer have been described by different authors, the chief of which are the following:

Simple Ulcer. A simple ulcer is a grayish lesion, quite superficial in character, associated with but little pericorneal injection. There is very little tendency to spread or to perforate.

Purulent Ulcer. This variety consists of an irregular spot of purulent infiltration, with a surrounding hazy zone

extending some distance from the ulcer itself. There is a marked tendency to perforation of the cornea, but little tendency to spread laterally. There may be pus in the anterior chamber, and the condition may result from traumatism or from some severe inflammation of the surrounding conjunctiva.

Indolent Ulcer (Transparent Ulcer, Absorption Ulcer). As a rule, this variety of ulcer is small and superficial, located near the centre of the cornea, and has little tendency to spread. There are very few accompanying symp-

FIG. 42.

Corneal ulcer. (Sichel.)

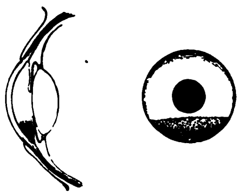
toms, the ulcer is very sluggish, and after healing there usually remains a permanent depression.

Sloughing Ulcer (Infectious Ulcer, Hypopyon Ulcer). In most cases a sloughing ulcer is due to local infection following a corneal traumatism. It is found in old people or in those whose vitality is much lowered. The so-called *serpiginous ulcer* is the most important type of this variety, and is usually crescentic in shape. The ulcer will be found spreading at one side and healing at the other, and there is a marked tendency to spread in depth as well as in a lateral direction. It is accompanied by pus in the anterior chamber, or *hypopyon* (Fig. 43). This latter

condition may consist only of a slight line of pus in the lower portion of the anterior chamber, or the latter may be completely filled. The pus results practically from the inflamed iris which accompanies the ulcer, and the name *hypopyon keratitis* has also been given to this condition.

Rodent Ulcer This is a rare form of corneal ulcer, beginning at the upper edge of the cornea and extending toward the centre. It is superficial in character, and is separated from the healthy cornea by an undermined grayish edge. There is a marked tendency to progress until the whole cornea has been destroyed, and it attacks elderly people, and has but little tendency to perforation.

FIG. 43.



Hypopyon, seen from the front, and in section, to show that the pus is behind the cornea. (Nettleship.)

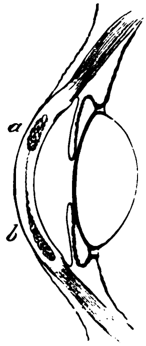
Circular Ulcer (Marginal Ring Ulcer). A circular ulcer is seen as a deep groove near the corneal margin, and gradually progresses until it may circle the entire cornea and cut off its nutrition. Perforation of the cornea and prolapse of the iris frequently accompany it.

Dendriform Ulcer is characterized by superficial ulceration of the cornea, accompanied by a number of small grayish lines spreading through the corneal tissue like the branches of a tree. It is probably due to a special micro-organism, and may be either acute with severe symptoms of irritation, or subacute and accompanied by very little irritation. After the ulcer has become healed the remaining scars present a figure similar to that previously occupied by the ulcerated area. A form of keratitis due to

malaria is occasionally seen which greatly resembles dendritic keratitis.

Exhaustion Ulcer (Keratomalacia) is a form of ulceration which may appear in the centre of the cornea or near its periphery; in the latter instance it usually appears as a ring abscess. The corneal tissue sloughs very rapidly, and is followed by perforation. The usual cause is extreme exhaustion of the patient, either after some acute illness or after a long attack of chronic diarrhœa or chronic dysentery.

FIG. 44.



a. Abscess. *b*. Onyx. (Nettleship.)

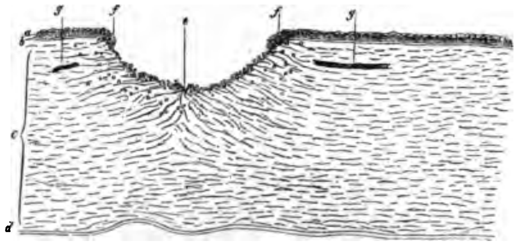
Abscess of the Cornea. Abscess of the cornea is a circumscribed area within the corneal substance containing pus. If it is deep it occasionally terminates without the breaking down of the superficial layers of the cornea and the formation of an ulcer; but, as a rule, the latter condition takes place, converting the abscess into a sloughing ulcer. Sometimes pus is seen in the anterior chamber, the aqueous humor is turbid, and there is an accompanying iritis.

Abscesses are usually the result of introduction of pathogenic micro-organisms through an abrasion of the superficial layers of the cornea. If the pus which has formed in the corneal substance occupies the lowest por-

tion of the cornea it is a condition to which the name of *onyx* has been given (Fig. 44).

Symptoms of Corneal Ulcer. Ordinarily a corneal ulcer begins as a slight grayish spot of infiltration of the corneal substance which is characterized by loss of transparency. This opaque area is more or less limited, and in a short time the overlying epithelial layer gives way and an ulcer is formed. The ulcer is surrounded by an area of infiltration for a short distance, and may spread either laterally or in depth. A traumatic ulcer is practically an infected abrasion of the cornea which may result in any one of the more serious varieties. In almost all cases there is photophobia and pain, the latter being more

FIG. 45.



Section of cornea in corneal ulcer. (Saemisch.)

marked when the superficial epithelium is involved. In those cases in which the photophobia is great the patient will sit in the dark or attempt to shade his eyes from the light in any manner possible. The lids are tightly closed in the severe cases, and there is profuse lacrymation. The lids may be swollen, there may be some pericorneal injection (especially if the ulcer is near the margin of the cornea so that the iris becomes involved), and sometimes bloodvessels pass from the conjunctiva over the margin of the cornea to the ulcer.

Causes of Corneal Ulcer. Ulceration of the cornea may be due either to traumatism or to disease. Abrasion of the cornea which becomes infected by the pyogenic germs

is the most frequent cause of extensive destructive ulcers. Corneal ulcers may follow inflammations, or may result from diseases, of the conjunctiva, lacrymal duct, or naso-pharynx. They are frequently seen as a sequel to measles or scarlet fever, and are also observed in greatly debilitated subjects with poor hygienic surroundings.

Diagnosis of Corneal Ulcer. The diagnosis is made by direct inspection. If the ulcer is large enough, its roughened surface showing the broken epithelium, its depth, ragged edges and accompanying infiltration will make the diagnosis easy. If the ulcer is small, oblique illumination, either alone or with the assistance of the corneal loupe, will aid in the diagnosis. Should there be doubt as to whether the minute patch is a corneal ulcer or a scar resulting from former ulceration, or should it be desired to decide how much of the opaque spot observed in the cornea is ulceration and how much is infiltration, the differentiation can be determined by dropping on the cornea a drop of a solution of fluorescin and then cleansing with a boric acid solution. This substance has the power of staining light green any portion of the cornea which has been deprived of its superficial epithelial layer, the other portions of the cornea remaining unchanged. It is best used in a 2 per cent. solution, which should be made up in a 2½ per cent. solution of carbonate of soda.

Prognosis of Corneal Ulcer. The prognosis of corneal ulceration must be based upon the size, character, and location of the ulcer. All ulcers of the cornea, except the most superficial, leave scars. A small scar in the centre of the cornea will interfere with the vision of the patient much more than a large scar situated at the periphery. A deep scar will also interfere more with the patient's vision than a superficial scar. If the ulceration shows a marked tendency to spread and involve other portions of the corneal tissue, or shows a tendency to extensive sloughing, the prognosis is bad. Much annoyance could be saved the physician if, in all cases of corneal ulceration, except the most superficial, as above stated, it were ex-

plained to the patient, or patient's friends, that there would be a resulting scar.

Complications and Sequelæ of Corneal Ulcer. Perforation of the cornea is an occasional complication during the course of ulceration. If the ulcer has extended deeply into the corneal substance, Descemet's membrane may protrude through the ulcerated area, forming a so-called *hernia of the cornea.* The process may stop at this point, or there may be perforation, followed by loss of the aqueous humor and prolapse of the iris (Fig. 49). A corneal fistula results as a rare complication, and if the iris has become attached to the ulcerated area the condition is known as

FIG. 46.

Total staphyloma of the cornea. (Sichel.)

anterior synechia. Upon healing of the ulcer permanent opacities of various degrees of density remain. If the opacity is very slight and cloud-like it is termed *nebula;* if it is slightly larger and more opaque, it is termed *macula;* if it is still larger and denser it is termed *leucoma;* and if the iris is incarcerated in the cicatrix, the condition is described as *adherent leucoma.* When the corneal tissue has been much thinned and weakened by the ulcerative disease, and begins to bulge, the condition is known as *staphyloma* (Fig. 46), which may be either *partial* or *total,* according to whether a part or the whole of the cornea is involved.

Treatment of Corneal Ulcer. It is impossible to lay down any hard-and-fast rules for the treatment of corneal

ulcers which will apply to all alike, as the treatment must be varied according to the exigencies of the case. When the condition is first seen a thorough search for the cause of the ulcer should be made. Occasionally small foreign bodies are found embedded in the ulcer or there may be misplaced cilia dragging over the cornea. If these conditions are discovered they should be removed before beginning the actual treatment of the ulcer itself. The following remedies in the order named will be found of service in most cases of simple corneal ulcer:

1. *Cleansing Lotions.* The conjunctiva should be irrigated at frequent intervals, depending upon the severity of the ulcer, with some mild cleansing lotion. This is done to free the ulcerated area of the accumulation of pus, and thus to place it in the best condition for healing. Many solutions are advocated for this purpose, among them being boric acid (gr. x–℥j), mercuric chloride (1:6000), formaldehyde (1 : 3000), permanganate of potash (1:2000), chlorine water, and many others. Whatever solution is employed should be *warm*, and this temperature is readily secured by standing the bottle containing the solution in a basin of hot water for a few moments before using, care being taken to test the heat of the solution on the back of the hand before placing it in contact with the eye.

2. *Moist Heat.* In applying moist heat to the eye the object is to keep up a continuous uniform high temperature for some time at regular intervals, and this is best done in the following manner: Several small pieces of lint or flannel, about three inches in diameter, are dipped into water as hot as the hand can be held in for an instant, or at the temperature of 120° F., and laid on the closed eyelids, three or four thicknesses being employed, as the heat is better retained in this way. In from one-half to one and one-half minutes these are replaced by others, more hot water being repeatedly added to keep up the temperature. Heat applied in this manner should be employed from ten to thirty minutes at a time, and should be used from three to eight times a day, according to

the virulence of the ulcer. The moist heat assists materially in relieving the pain and promoting the process of repair.

3. *Instillation of a Mydriatic.* A drop of a solution of sulphate of atropine (gr. iv–℥j) is dropped on the cornea two or three times a day. This combats any impending inflammation of the iris and relieves the general irritation of the eye, in this manner acting favorably upon the ulcer itself. Should the ulcer be situated near the margin of the cornea, a drop of a solution of sulphate of eserine (gr. ½–℥j) has been recommended by some authors. It is stated that the latter promotes healing by stopping the migration of the white blood corpuscles, by promoting absorption through dilatation of the ciliary vessels, and by reducing intraocular tension if this is elevated. If employed it should be instilled from three to six times a day, and as it possesses a tendency to produce congestion of the iris and ciliary body, it is better, during the time of its employment, to counteract this tendency by instilling at night a drop of the atropine solution. Should there be at any time any complication involving the iris or ciliary body, the eserine solution must be discontinued and the atropine solution employed in its place. In those cases which are occasionally observed in which the atropine solution produces a conjunctivitis, it is necessary to employ some other mydriatic, such as solutions of hyoscine, duboisine, or scopolamine

4. *Protection.* The eye should be protected by dark glasses or a bandage. If much discharge is present it is evidently improper to dam it up in an already inflamed eye, in such a case dark glasses being preferable. If the amount of discharge is small, a well-applied bandage will materially assist in the reparative process, it being left off sufficiently long for the application of other remedies. It should be applied lightly but firmly, and should keep the lids closed and at rest without making any pressure on the eyeball, unless this should be required. It also keeps out such extraneous matter as dust, and should be

worn until the floor of the ulcer is covered with epithelium, which protects it from external irritation. Should the ulcer seem disposed to spread rapidly, to become virulent in action, and to involve greater destruction of the corneal tissue in spite of the faithful employment of the above-mentioned remedies, the measures for checking its progress and producing resolution must necessarily be somewhat more severe. In the order in which their application will probably be found most satisfactory they are as follows:

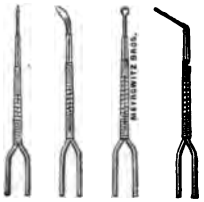
5. *Curettement.* The ulcer may be curetted by an instrument specially devised for the purpose, or if this is not at hand, it may be done more or less perfectly with a sterilized probe or stick, on the end of which has been wrapped a wisp of aseptic absorbent cotton. The cornea is then anæsthetized with a solution of holocaine, this remedy being given the preference in corneal disease, as it is believed that it does not produce a softening of the epithelium, as does cocaine. A drop of a 2 per cent. solution of fluorescine is next instilled and the excess washed off, thus distinctly mapping the area of ulceration. The sides and bottom of the ulcer are next relieved of the slough as far as possible. Some surgeons advise the dusting of some finely-powdered iodoform upon the ulcerated area, to be followed by the application of a light bandage. This is hardly required, however, except in cases of great severity.

Hydraulic curetting as a method of treatment has recently been suggested, and it is carried out by having a receptacle containing the antiseptic solution to be employed held on a higher level than the eye, and a nozzle, with a fine point, connected with the former by means of a rubber pipe, to direct the stream for some minutes against the ulcer.

6. *Topical Applications of Chemicals.* If, after a fair trial of the means just described, the ulcer should continue to grow worse, it is best to attempt to bring about a healthy condition by the application of some one of the chemical agents used for the purpose. The ulcer is first curetted,

as described, the eye having been holocainized and the ulcerated area mapped out with fluorescine, and the chemical agent brought into contact with every portion of it by means of a wisp of cotton wrapped on a pointed probe or stick previously sterilized. For this purpose one of the simplest as well as one of the best stimulants is the tincture of iodine. The stronger agents are solutions of silver nitrate (gr. xxx–℥j), pure carbolic acid, bichloride of mercury (1 : 500), and formaldehyde (1 : 50). In applying these, care must be taken to touch only the affected parts, as an application to the healthy cornea would result in an opacity of greater or lesser density; and as an opacity always results from corneal ulceration, except the most superficial, it must be our object to keep it as small as possible.

FIG. 47.



Eye electrodes for cautery.

7. *The Actual Cautery.* Among the more severe remedies at our disposal, when those previously referred to fail to check the progress of the ulcer, is the actual cautery, and in very few cases does the proper use of it fail to prevent the further extension of the disease. The elaborate cautery outfits of the shops, if they are at hand, may be employed, but a simple as well as most effective cautery probe can be made by inserting a piece of medium-sized platinum wire into the so-called "universal" laryngoscope handle. This is brought to red or white heat by means of the flame of an alcohol lamp, and the ulcerated portion of the cornea quickly touched. During the application of the more severe remedies the use of hot fomen-

tations, cleansing lotions, mydriasis and protection is to be continued at proper intervals.

8. *Intranasal Treatment.* In those cases having considerable discharge of mucus or muco-pus from the nares, the parts should be cleansed several times a day with a mild alkaline solution, such as Dobell's solution (25 per cent.), and followed by the insufflation of some protective powder. The following answers the purpose very well:

℞.—Pulverized camphor	30 grains.
Pulverized aristol	10 "
Pulverized menthol	20 "
Subcarbonate of bismuth	2 drachms.—M.

If the mucous membrane of the turbinated bones is much swollen it may be sprayed with a solution of antipyrine (gr. x to xxx–℥j) or adrenalin chloride (1–10,000), the parts then cleansed with the alkaline solution, and this followed by the spray of an oily preparation:

℞.—Pulverized camphor	30 grains.
Pulverized menthol	30 "
Liquid petrolatum	1 ounce.—M.

A topical application of the compound tincture of benzoin has also been found of much benefit in these cases. If there is any gross lesion, such as a polyp, a spur, septal deviation, or adenoid growths, the condition must be attended to as early as possible, and this also applies to any disease of the lacrymal duct or conjunctiva.

9. *Constitutional Treatment.* As with disease manifesting itself in any other part of the body, the constitution must be put in the best possible condition. Instead of confining patients to a dark room, as a rule, it will be better to permit them to pass several hours a day in the open air, the eyes being properly protected. Any particular diathesis that is present must be especially attended to, and in large, progressive ulcers, the system must be supported by stimulants and such remedies as quinine and strychnine administered. In the beginning it is advisable to give a brisk purgative, followed by a saline draught. The diet must be digestible and nourishing, all sweets

being interdicted. If the pain is severe and continuous and not relieved by the means previously suggested, the analgesics, or even opiates, are indicated.

Within the past few years *subconjunctival injections* of certain solutions have been advocated by some surgeons in the treatment of corneal ulceration. Bichloride of mercury, cyanuret of mercury, and physiological salt solutions are given the preference. The author has seen but little benefit from their use in the treatment of this class of cases.

Treatment of Complications of Corneal Ulcer. If, at any time during the treatment of the disease, *perforation* of the cornea is threatened, the application of a firm pressure bandage may prevent the accident. If, however, this does not suffice, perforation may be anticipated by a *paracentesis of the cornea.* This is performed by means of a

FIG. 48.

Paracentesis needle.

paracentesis needle, the point of selection being about the centre of the lower outer quadrant of the cornea, or through the floor of the ulcer. The eye having been anæsthetized and a speculum having been introduced to separate the lids, the knife is entered through the corneal tissue to the depth of 1 mm. or 2 mm., and slowly withdrawn to permit the gradual loss of aqueous humor. A pressure bandage is then applied. If *perforation* should take place, however, without any such procedure, and the iris become incarcerated in the lips of the wound, an effort should be made to replace it with a probe, if it is of recent occurrence, followed by a pressure bandage and rest in bed. If this cannot be done, or if the prolapse is a large one and recent, the prolapsed portion should be excised. If the prolapse has occurred some days before, it is probably better not to excise it.

In some severe cases of ulcer with hypopyon which do not respond to the usual treatment, it is sometimes necessary to perform an operation described as *Saemisch's section.* This consists in entering a cataract knife through the cornea about 1 mm. to the outer side of the ulcerated area, passing it directly across the anterior chamber with its cutting edge directed forward, and making a counter-puncture about 1 mm. beyond the ulcer on the opposite side, cutting directly forward through the corneal layers. This evacuates the pus from the ulcer and the infiltration from the layers of the cornea, and permits the escape of the hypopyon, if the latter is liquid. If it is thickened

FIG. 49.

Prolapse of iris in a perforating ulcer. (Demours.)

and hard, it is necessary to withdraw it from the anterior chamber with a pair of iris forceps.

Treatment of Results of Corneal Ulcer. The opacities which follow all ulcerations of the cornea may be somewhat improved if they are only superficial in character. Massage by means of yellow oxide of mercury ointment, a small piece being placed on the cornea, and the massage performed through the lid, sometimes improves the condition. This same treatment also promotes the absorption of corneal ulceration in the late stage when the irritative symptoms have subsided and the ulcer has become sluggish. Galvanism has also been recommended for the

removal of corneal scars, but the author has not seen any improvement follow its use. If the ulceration has been followed by perforation and the formation of anterior synechia, the latter may sometimes be divided, if small, by means of *Lang's operation.* This consists in entering a very small knife, devised by Mr. Lang for the purpose, near the periphery of the cornea opposite to the synechia to be divided, and by passing it across the anterior chamber and using the point of entrance through the cornea as a fulcrum, the synechia is divided as close to its attachment in the scar as possible. In those cases in which the dense leucomatous area lies in the centre of the cornea, blocking out visual acuity, the latter may be improved by means of an *optical iridectomy.* Before this operation is attempted, the pupil should be dilated and the improvement in vision noted. The iridectomy should be made behind the clearest available portion of the cornea, but, other things being equal, the artificial pupil should be placed downward and inward.

FIG. 50.

Tattooing needle.

Tattooing the corneal scar is occasionally practiced for cosmetic purposes. The eye is first anæsthetized, and some India ink, which has been made into a paste with water, is placed over the area to be tattooed and pricked into the corneal scar-substance with a needle devised for this purpose. The pricks should be made obliquely, and the cornea washed from time to time so that the effect of the tattooing may be noted. As soon as any ciliary irritation manifests itself the operation should be stopped for the time being, atropine instilled, and repeated at some future time. In a large scar two or three sittings are necessary to produce the best results.

If the formation of a *corneal staphyloma* follows corneal

ulceration, its further progress can be prevented by the application of a pressure bandage. If, however, the staphyloma becomes sufficiently large to prevent proper closure of the lids, some operation for the removal of the protruding portion, or even enucleation, or evisceration, of the eyeball may become necessary.

Herpetic Keratitis. This frequently occurs in conjunction with herpetic inflammation of the lids, and also occasionally follows an attack of pneumonia or some attack of catarrhal inflammation of the respiratory tract, but may be seen when such inflammation is not present. It begins with the appearance of numerous small vesicles on the cornea which, in a short time, coalesce and form superficial linear ulcers of considerable length. There is much pain, photophobia, and lacrymation. The disease is of infrequent occurrence under the twentieth year of age. In some cases the tension of the eyeball is reduced.

Treatment. The disease should be treated locally by cleansing lotions, the use of atropine and yellow oxide of mercury ointment. Sometimes the latter may be combined, as in the following:

℞.—Sulphate of atropine	¼ grain.
White petrolatum	1 drachm.—M.

If there is much pain, hot fomentations and occasional instillations of a 1 per cent. solution of holocaine may be employed. The eye should either be bandaged or covered by a shade or smoked glasses. The constitutional treatment should be administered as in herpetic inflammations elsewhere.

Bullous Keratitis. This is a chronic inflammation of the cornea in which one or more bullæ appear. There is usually considerable pain, photophobia, and lacrymation. After a bulla has ruptured there results a large ulcer with an infiltrated base. The bullæ are apt to recur again and again, and the condition is usually found in eyes in which the nutrition has been lowered by previous disease, as in chronic iridocyclitis or glaucoma. It is also seen after

extensive corneal abrasions. The condition is supposed to be due to œdema of the deeper epithelial cells.

Treatment. The elevated portion of each bulla may be cut off with a small pair of scissors, and the base stimulated by local applications of a weak solution of nitrate of silver, or the tincture of iodine. Hot fomentations, followed by the instillation of atropine will, as a rule, assist materially in controlling the pain. If this fails, some one of the coal-tar derivatives, or even a hypodermic injection of morphine may be required. Some cases do better with the eye lightly bandaged. If the vision of the eye is entirely destroyed, and there is constant repetition of the attacks, enucleation, or one of its substitutes, may be required.

Vascular Keratitis. Vascular keratitis, or *pannus*, is a condition of the cornea which usually accompanies trachoma, and is the result of friction on the cornea by the roughened lids, the vascularity affecting the superficial layers of the cornea. Vessels appear advancing from the periphery and pass just beneath the epithelium, rendering it uneven. These increase rapidly in number, and may eventually form a red, flesh-like surface over the entire cornea. Vision is impaired, and in some cases almost abolished, and frequently the vascularity disappears upon the application of treatment to the roughened lids. In some cases no trace of the previous vascularity remains, but in the majority vision is more or less permanently impaired.

Treatment. The cause which is producing the vascularity must be removed, and if this is done, in most cases it will suffice to bring about a cure. In severe cases an operation which has for its object the destruction of the vessels which supply blood to the cornea may be performed. The operation is *peritomy*, and consists in dissecting up a narrow strip of the conjunctiva and subconjunctival tissue about the whole circumference of the cornea if the bloodvessels come from all sides. If the pannus occupies a portion of the cornea only, the dissec-

tion of the strip may be confined to that portion of the conjunctiva from which the vessels are derived. The width of the strip should be from 2 to 5 mm. Instead of dissection, the galvano-cautery may be employed for the same purpose. A narrow electrode may be passed entirely around the cornea, or around a portion of it, as required, burning sufficiently deep to destroy all vessels that pass to the corneal surface. These operations materially aid in clearing up dense vascularity of the cornea. Some surgeons have advocated the direct application of a sulphate of copper crystal to the corneal surface. Atropine, cleansing lotions, and hot fomentations are of benefit, as in other corneal affections. (See also Treatment of Granular Conjunctivitis.)

Keratitis e Lagophthalmo. This is a variety of corneal inflammation which is brought about by continuous exposure of the cornea from some cause, resulting in desiccation and denudation of the epithelium, and followed by the entrance of micro-organisms. It has been seen in paralysis of the orbicularis palpebrarum, in excessive exophthalmos, and after traumatism of the lids resulting in exposure of the cornea.

Treatment. The cause should be removed by operation, if possible. If this cannot be done, the eye must be protected by a bandage from all irritating influences, as dust, wind, smoke, etc. If the cornea becomes ulcerated, the treatment of corneal ulcers is indicated.

Xerotic Keratitis (**Keratomalacia**) is a term applied to a variety of keratitis observed in poorly-nourished individuals, especially infants and children after some acute or chronic wasting disease. There is considerable dryness of the conjunctiva, and the surface of the epithelium becomes flaky and peels off. There may be a marginal ulcer with tendency to perforation, or the whole cornea may assume a yellowish appearance, due to disintegration of its tissue. Occasionally the cornea is destroyed very rapidly, but, as a rule, several days are required for this process. There is very little pain.

9

Various micro-organisms have been found during the progress of the disease, but it has not been definitely ascertained that any one is the specific cause. That which is most frequently seen is the *pseudodiphtheritic*, or *xerotic bacillus*.

Treatment. The nutrition should be improved, if possible, and the application of hot fomentations and cleansing lotions may be tried.

Neuroparalytic Keratitis is a variety of corneal inflammation which is observed after disease or injury of the ophthalmic branch of the fifth nerve, or its nuclei. For example, it follows disease of the Gasserian ganglion, or its removal for trifacial neuralgia, and is partly trophic and partly traumatic in character. Ulceration frequently occurs, but is usually relieved if the cornea is guarded from infection. The cornea is deprived of its sensation, and there is usually other evidence of disease of the nerve.

Treatment. The treatment consists in proper protection of the eye after operation or injury, or as soon as the disease manifests itself, by the application of a protective bandage, Buller's shield, or by suturing together the lid margins. For ulceration, in addition to careful protection, the instillation of atropine, together with the use of a cleansing lotion and hot fomentations, will usually suffice. After traumatism producing this condition, the cornea must be protected for several weeks.

Filamentous Keratitis is a very rare condition, in which there is a development of small filaments of tissue from wounds or blebs on the cornea. These filaments are frequently twisted and have bulbous extremities. They sometimes rapidly disappear, but may persist for some time, or return after removal.

Treatment. The treatment is directed to the condition which gives rise to them.

NON-SUPPURATIVE DISEASES OF THE CORNEA.

Interstitial Keratitis (Parenchymatous, Strumous, Syphilitic, Inherited, Diffuse Interstitial Keratitis). This is a condition in which there is an infiltration of the deep layers of the cornea with small cells, producing more or less marked opacity of the cornea, usually without the production of pus, but always with superficial or deep vascularization.

Fig. 51.

Section of cornea in interstitial keratitis. (Wedl.)

Symptoms. At first there is slight pain, accompanied by marked photophobia. In a few days vision becomes impaired, and there is noted slight ciliary congestion and lacrymation. If the cornea is examined with a magnifying-glass, a faint cloudiness may be detected in its substance, usually near the centre, but occasionally near the margin. This cloudiness increases gradually, remaining of a whitish

tint in the mild cases, but becoming more dense and somewhat yellowish in the severe cases. Examination with a magnifying glass shows that the cloudiness is composed of numerous spots scattered through the corneal substance, and that the cornea is traversed by numerous

FIG. 52.

Interstitial keratitis. (Nettleship.)

minute bloodvessels. In some cases the vascularity is sufficiently marked to produce the so-called *salmon patches* of the cornea, as described by Hutchinson. The cloudiness gradually spreads until the whole cornea becomes involved, with the exception, perhaps, of a narrow rim at the margin. There is great irritability, photophobia, and lacrymation, and a marked tendency to iritis and

FIG. 53.

Vessels in interstitial keratitis. (Nettleship.)

iridocyclitis as complications. After a period of time, varying from a few weeks to many months, the cornea begins to clear, usually in the reverse order from which it became opaque. Some opacity almost always remains, though in some cases it may be very slight. Many years

after an attack minute bloodvessels can be detected in the cornea with the aid of a magnifying glass. The disease is very slow in its course, requiring from six to eighteen months, and, as a rule, both eyes are affected. It may be that the second eye becomes affected shortly after the first, or not until the latter has very nearly, or entirely, become clear.

Causes. The origin of the disease in most instances is due to inherited syphilis. In most of these cases there are usually present other conditions which assist in determining the cause, such as a sunken bridge of the nose, scars at the angles of the mouth, dwarfed stature, oldish appearance of the patient, and the so-called *Hutchinson's*

FIG. 54.

FIG. 55.

FIG. 56.

Pemanent incisors of inherited syphilis. (Hutchinson.)

teeth. The upper incisors are generally those most affected. They are narrow, placed apart from each other, round, peg-shaped, and notched at their extremities. Often the teeth decay early in life, and stumps only remain. There may be enlargement of the cervical and submaxillary lymphatic glands. The affection is most frequently observed in childhood between the ages of eight and fifteen years, but has been observed at birth and as late as the thirty-fifth year. In most instances it is due to inherited syphilis (70 per cent.), but is occasionally seen as the result of acquired syphilis. It may also be caused by scrofula, rheumatism, rachitis, and depressed nutrition.

Treatment. The treatment is both local and general. The local treatment consists in the use of atropine to pre-

vent iritis and in the application of hot fomentations to allay the pain and promote the absorption of the corneal infiltration. The eyes must be protected from bright light by means of smoked glasses, and in severe cases the room in which the patient sits should be kept moderately darkened. If the inflammatory condition is marked, or if there should be tenderness in the ciliary region, one or two Swedish leeches should be applied to the temple. The cause should be ascertained and removed. In most instances a long-continued course of mercury and of iodide of potash will probably be required. The most satisfactory form of administering the mercury is by inunctions, one-half drachm, or a drachm, being rubbed into the skin

FIG. 57.

Keratitis punctata. (Nettleship.)

twice a day. Symptoms of ptyalism should be watched for, and upon their appearance the remedy must be discontinued and a mouth wash of chlorate of potassium given. The administration of cod-liver oil, syrup of the iodide of iron, quinine and arsenic, are called for, according to the condition present. Nourishing food, exercise, frequent bathing, and hygienic surroundings will materially assist in the treatment. In the late stage, after the subsidence of the acute inflammatory symptoms, massage of the cornea with an ointment of the yellow oxide of mercury, or subconjunctival injections of physiological saline solution, will assist in the clearing of the corneal opacity.

Punctate Keratitis is, as a rule, secondary to disease of some portion of the uveal tract, and is characterized by

the appearance of a number of opaque dots on the posterior surface of the cornea, which are arranged in the shape of a triangle, its apex toward the centre and its base toward the periphery of the cornea. The name *Descemetitis* has also been given to this affection. It is most frequently seen in young subjects, and is often syphilitic in origin.

Treatment. The treatment consists in the removal of the cause and the employment of atropine, the eye being carefully watched from day to day to see that the intraocular tension does not rise. Occasionally it is necessary at a subsequent period to perform an iridectomy to check the iritis, or for optical purposes.

Superficial Keratitis is a disease probably somewhat similar to herpetic corneal inflammation, and has been described under many names, such as *central* and *subepithelial keratitis*, *herpes of the cornea*, etc. It usually begins with the symptoms of acute conjunctivitis. In a few days there appear numerous small, gray spots in the superficial corneal layers, probably below Bowman's membrane, the overlying cornea being slightly hazy and the epithelium slightly elevated. There may also be numerous fine lines noted between the spots. The affection is of long duration, occasionally lasting for many months.

Treatment. The treatment consists in relieving the conjunctival irritation by mild antiseptic and astringent lotions, to be followed by the use of an ointment of the yellow oxide of mercury. Full doses of quinine and the application of a galvanic current along the region of the supraorbital nerve have been recommended. Treatment should also be directed to the mucous membrane of the nasopharynx.

Riband-like Keratitis (Trophic Keratitis). A transverse calcareous film is occasionally found in that portion of the cornea which is most exposed, and consists of a transverse opacity, subepithelial in character, which can be removed, and which is composed of lime salts. It occurs in elderly people, is usually symmetrical, tends to

progress, but does not spread beyond the cornea. Gout and a uric acid diathesis have been suggested as causes.

Another variety of the disease consists of a transverse band, or opacity, extending across the cornea of eyes which have become blind from previous disease. It is less sharply defined, however, and the opacity is roughened, whereas in the other variety it is smooth. It is usually seen in the lower third of the cornea of eyes with impaired nutrition, and is considered trophic in its nature.

Treatment. The treatment consists in the use of cleansing lotions, and, in the first variety, of the removal of the anterior epithelium and the scraping away of the calcareous film so as to obtain a transparent area, if this is possible. An optical iridectomy may be required.

Sclerosing Keratitis is a name given to a form of opacity of the cornea which is associated with prolonged attacks of scleritis and iridochoroiditis. It may begin as a triangular, whitish patch, with its base on the sclera and its apex toward the centre of the cornea, and is interstitial in character, the epithelium, as a rule, not being changed. If it follows a prolonged inflammation of the uveal tract, the opacity may extend as a band wholly or partially around the corneal circumference.

Treatment. The application of the galvano-cautery to the base of the lesion has been suggested, but treatment is of little avail.

Profound Keratitis is a variety of deep-seated corneal inflammation found in adults, consisting of a grayish central corneal opacity, accompanied by symptoms of irritation. As a rule, the opacity becomes absorbed in a few weeks.

Treatment. The treatment required is that of interstitial keratitis.

Arcus Senilis consists of an opacity about a millimetre in width, which is usually seen near the margin of the cornea in elder people. It may pass entirely aroundly the cornea, or around a portion only, and there remains a narrow strip of clear cornea between it and the sclera. Occasionally it is observed in comparatively young sub-

jects. It is due to a colloid degeneration of the superficial layers of the cornea, and an incision heals as readily as in normal tissue.

FIG. 58.

Arcus senilis. (Nettleship.)

Corneal Opacities due to Deposits. Opacities of the cornea are occasionally observed due to *metallic* and *chalky* deposits. The former are most frequently those of carbonate of lead, which forms a white, densely opaque mass. It results from the employment of solutions of acetate of lead in an eye in which a corneal ulcer is present. A deposit of chloride of silver is sometimes produced as a result of the use of strong solutions of nitrate of silver in the treatment of corneal ulcers, followed by the instillation of solutions of mercuric chloride. In some of the cases of chronic superficial keratitis met with in trachoma, chalky deposits are found.

Treatment. The treatment consists of removal, if possible.

Bloodstaining of the Cornea. Bloodstaining of the cornea is most frequently seen after an injury, accompanied by hemorrhage in the anterior chamber. The cornea presents a brownish or rust-colored appearance, with the exception of a narrow strip at the margin. The condition looks not unlike the dislocation of an amber-colored lens into the anterior chamber. The discoloration is produced by numerous granules of hæmatoidin which have become deposited in the corneal tissue proper. At least two years are required for the disappearance of the opacity.

Keratoconus (Conical Cornea) consists of a bulging forward of the central portion of the cornea, forming a cone,

the base of which corresponds to the periphery, the apex to the centre of the cornea. The cone is transparent, and a high degree of myopia in the centre of the cornea is produced by this condition. It is probably due to a combination of causes, such as increased intraocular tension, weakness of the centre of the cornea, and mal-nutrition.

Diagnosis. It may be diagnosed by direct inspection, or by examination with the ophthalmoscope. During this examination a very well-defined shadow passes over the

FIG. 59.

Conical cornea. (Dalrymple.)

apex of the cone. It may also be noted by the examination of the corneal reflex.

Treatment. On account of the very imperfect shape of the cornea vision is indistinct, and it is difficult to give glasses that will be of much benefit to the patient. Occasionally, however, some portion of the cornea may be discovered through which the patient can obtain sufficient vision, or it may be that the wearing of a correcting lens which is entirely opaque, with the exception of a minute central portion, will improve the vision. In refracting the eye of such a case it is best to employ a weak solution of eserine (gr. $\frac{1}{8}$–℥j) for some time before attempting to correct the refractive error

Operative Treatment. Various operations have been devised to improve the condition. An operation which has given beneficial results consists in the removal of a small circular piece of corneal tissue from the apex of the cone by the use of a small trephine. After the piece has been removed, the cornea heals with a small central cicatrix, and the conical curve is much reduced. Another operation is to excise an oval piece of the cornea at the apex. Other operators have advised the use of the galvano-cautery in cauterizing the apex of the cone, which has been followed by improvement of the visual acuity. Repeated paracentesis of the cornea, or even a small iridectomy for optical purposes, have also been advised.

Tumors of the Cornea. Corneal tumors are exceedingly rare, but occasionally *epithelioma, sarcoma,* and *dermoid* tumors are observed. The variety of *epithelioma* resembles closely that which is seen in other parts of the body. When *sarcoma* is found it is usually subsequent to sarcoma in other parts of the eye or adjacent tissues. *Dermoid tumors* are congenital in origin and present the ordinary tissues of dermoid tumors in other parts of the body. *Fibroma* and *papilloma* have also been recorded.

Treatment. The treatment consists of complete excision, if practicable, and in cases of epithelioma it is advisable, in addition, to cauterize the base of the tumor.

Congenital Anomalies. Congenital anomalies of the cornea are rare, but the following defects have been observed: *Dermoid tumors* which, when present, are usually situated in the corneo-scleral margin, and are sometimes seen in conjunction with some other deformity of the eye; *congenital opacities,* which may be due to intra-uterine inflammation or to arrested development; *microphthalmos,* or that condition in which the eye remains in an undeveloped state, all the diameters of the cornea being reduced. In *sclerophthalmia* there is an imperfect boundary between the cornea and the sclera, the latter encroaching on the former, so that only a portion of the cornea remains clear.

CHAPTER VI.

DISEASES OF THE SCLERA.

Episcleritis is an inflammation occurring in the anterior segment of the sclera, affecting the episcleral tissue.

Symptoms. There is a deep congestion of the affected part, which presents a dark red appearance just beneath the conjunctiva, and over which the conjunctiva, with its vessels, can be moved by making slight pressure through the eyelid. The conjunctiva becomes involved to a certain extent, and there is present a small nodule beneath the surface, which, as a rule, appears in the ciliary region on the temporal side of the cornea. There may, however, be a number of nodules, and they may occur at any portion of the ciliary zone. The affection is very slow in its progress, and often extends into the deeper portions of the sclerotic coat. There is a marked tendency to travel around the cornea, affecting at intervals the whole of the anterior segment of the globe. It is not infrequent to observe a new patch develop as a former patch is disappearing. It is occasionally associated with a chronic form of keratitis, and is also complicated in some cases by inflammation of the iris, ciliary body, and anterior segment of the choroid. It is then known as *anterior uveitis*.

Causes. The condition is most frequently observed in gouty and rheumatic individuals, and occurs more frequently in the female sex than in the male, although according to some authors the reverse is true. It is oftentimes noticed about the time of the appearance of menstruation. It is more frequently seen in adults, and anæmia and syphilis are undoubtedly predisposing causes.

Treatment. Local treatment alone is seldom sufficient. Hot applications may be employed with benefit. Pain

may be relieved and the tendency to iritis removed by the instillation of atropine. If the pain is intense and unrelieved by these means, a few drops, at frequent intervals, of a solution of holocaine may be employed. Weak solutions of eserine (gr. $\frac{1}{6}$ to $\frac{1}{4}$–℥j.) sometimes assist in relieving the condition. In certain cases subconjunctival injections of a few drops of the physiological salt solution, repeated on alternate days, produce rapid improvement. In the chronic cases massage with ointment of the yellow oxide of mercury, or even curettement, or the application of the actual cautery to the nodule, has been employed.

The *constitutional treatment* consists in the administration of remedies for the gouty or rheumatic condition. Large doses of salicylate of sodium or iodide of potassium are called for, and diaphoresis by means of Turkish baths, or hypodermic injections of hydrochlorate of pilocarpine will be found of use in some cases. Frequently, the condition appearing in females does not disappear until after any existing menstrual or uterine disorder is corrected. Errors of refraction or abnormal conditions of the external ocular muscles should be removed, and the eyes must be protected from strong light by the use of smoked glasses.

Scleritis is an inflammation of the sclera which appears in the form of a bluish-red injection occupying most of the exposed portion of the scleral membrane. There is marked pain and tenderness over the ciliary region, the former being intense and most severe at night. The tenderness is marked on pressure, and is oftentimes associated with increase of the intraocular tension, which may result in glaucoma. The disease begins with vascularity of the conjunctival and episcleral vessels, which may be in circumscribed patches, as in episcleritis, but the inflammation soon becomes general. There is lacrymation, photophobia, and occasionally slight discharge, together with some diminution of the visual acuity. The principal difference between the superficial and deep forms of inflammation of the sclera is a decided tendency of the latter to affect other portions of the eye, giving rise to serious complica-

tions. In severe cases, after prolonged attacks, the sclera may become so thin as to permit the formation of a staphyloma. The course of the disease is chronic, both eyes are usually affected, and the iris, ciliary body, choroid, vitreous, or cornea may take part in the inflammatory process.

Causes. Exposure to cold, rheumatism, gout, scrofula, syphilis, and disturbances of menstruation are instrumental in the production of this disease. Occasionally a form of *sclerokeratitis* is met with in young and middle-aged subjects with depressed nutrition, in which no definite cause can be found.

Treatment. The treatment of scleritis is largely similar to that of episcleritis. Locally, atropine, hot compresses, holocaine, and in some cases a weak solution of eserine will be found most satisfactory. The latter must not be employed if the iris or ciliary body is involved. If the congestion is marked, one or two Swedish leeches applied to the temple, or bleeding by means of the artificial leech, is of benefit. In *rheumatic* cases the administration of salicylate of sodium, salicine, aspirine, and iodide of potassium, produces the best results; in *gouty* cases, proper diet, some form of colchicum, iodides, and mineral waters; in *scrofulous* cases, cod-liver oil and syrup of the iodide of iron; and in *syphilitic* cases, some form of mercury, in addition to the iodides, will be found the most effective treatment.

Transient Episcleral Congestion is a name which has been given to a sudden, and at times intense, hyperæmia of the sclera and overlying conjunctiva, which lasts from a few hours to a few days. Fuchs describes it under the name *episcleritis periodica fugax*. Some time before Fuchs' description, however, it was termed by Swan M. Burnett *vasomotor dilatation of the vessels*. It is probable that the *hot eye* of Hutchinson is similar in character. The affection is liable to recur for years, is usually painful, and is accompanied by photophobia and lacrymation. It is rarely attended with any danger to vision.

Treatment. The treatment consists in the application of dry heat for the relief of the pain, together with instillations of holocaine or cocaine if required. Any existing diatheses must be removed. Occasionally a change of climate is the best means of obtaining permanent relief.

Staphyloma of the Sclera sometimes results from a weakening of the scleral coat by injury, scleritis, gumma of the ciliary body, or choroiditis. It is termed, according to its location, a *ciliary*, *equatorial*, or *posterior staphyloma*.

Treatment. Nothing can be done in the way of treatment except the removal of the causes which produce the thinning and bulging of the scleral coat. If the intraocular tension is increased, an iridectomy; if the eye is useless and so large that there is difficulty in closing the eyelids, enucleation or evisceration becomes necessary.

Tumors of the Sclera are of exceedingly infrequent occurrence, but *fibroma*, *sarcoma*, *enchondrôma*, and *osteoma* have been described. The *benign growths* should be removed, if this can be done without injury to the eyeball; the *malignant growths* must be removed, even if the eyeball has to be sacrificed.

Melanosis of the Sclera is a term which has been given to the appearance of a few dark spots. They are frequently congenital, but have also been observed in Addison's disease.

CHAPTER VII.

DISEASES OF THE IRIS AND CILIARY BODY: SYMPATHETIC IRRITATION AND SYMPATHETIC INFLAMMATION.

DISEASES OF THE IRIS.

Hyperæmia of the Iris is, perhaps, more a symptom than a disease of the iris itself, and is found in association with many acute affections of the eye, as purulent conjunctivitis, keratitis, scleritis, etc., and may be the beginning of a true inflammation of the iris. It may be recognized by slight discoloration, by sluggish contraction of the pupil and by moderate pericorneal injection.

Treatment. It should be treated by removing the cause which gives rise to the hyperæmia and by the instillation of some mydriatic for a short time.

Iritis is a term which has been given to various types of inflammation of the iris, all of which have more or less symptoms in common.

Symptoms. The symptoms of iritis may be divided into two classes, objective and subjective. The *objective symptoms* are *change in the color of the iris*, together with *irregularities of its surface*, the latter being due to local swellings or to exudate. *Pericorneal injection* as a fine pinkish zone surrounding the cornea is also observed, due to congestion of the non-perforating branches of the ciliary vessels. The *pupil is contracted*, and its reaction to light or to the mydriatics is abolished or impaired. *Posterior synechiæ* are present on account of inflammatory attachments between the iris and the capsule of the lens (Fig. 60). When a pupil is found to be sluggish in its reaction

the presence of synechiæ may be promptly ascertained by the instillation of a mydriatic which will produce irregu-

FIG. 60.

Iritis. The pupil is irregularly contracted, and circumcorneal congestion is marked. (Würdemann.)

lar dilatation of the pupil (Fig. 61). These attachments may be one or many, and may vary greatly in size.

FIG. 61.

Posterior synechiæ. (Jaeger.)

(See Plate V., Fig. 1.) If the whole pupillary border of the iris is attached to the capsule of the lens it is usually

known as *annular synechia.* The *cornea is more or less hazy* in all varieties of iritis, as can be determined by examination with a strong magnifying glass, but the haziness is especially marked in that variety of iritis to which the name of *serous* has been given. This haziness is more or less due to deposits upon Descemet's membrane or to infiltrations in the corneal substance. The *aqueous humor may be turbid,* owing to the presence of pus, blood, or exudate.

The *subjective symptoms* consist of *pain,* which may sometimes be located within the eye, or may affect the brow and temple. It is very severe, and frequently of a throbbing character, and is usually worse at night. There is some *disturbance of vision,* which is produced by the existing cloudiness of the media and is, therefore, worse when the disease has extended to the deeper structures of the eye. There may be some *tenderness of the eyeball* under pressure, and *photophobia* and *lacrymation* may accompany the other symptoms.

Varieties. *Pathologically,* we have three varieties of iritis, viz., *plastic, serous,* and *parenchymatous.*

Plastic iritis derives its name from a tendency which it possesses to produce adhesions between the iris and the capsule of the lens, and of forming an occlusion of the pupil. It may run a subacute or a chronic course, and is the most common form of iritis. Occasionally not only is the pupillary space filled, but there is deposited in the anterior chamber an exudate which consists of plasma of the blood and which coagulates when it comes in contact with the aqueous, and fills the whole anterior chamber with a spongy mass. This condition is known as *fibrinous* or *spongy iritis.*

Serous iritis is a form of iritis which the older writers called *descemetitis,* but which, in fact, has nothing to do with inflammations of Descemet's membrane. It has received its name from the fact that the exudate from the iris is serous in character. There are also some deposits of a fibrous nature on the posterior surface of the cornea,

PLATE V.

Anomalies and Diseases Affecting the Iris and Pupil.

(Würdemann.).

FIG. 1.—Iritis with posterior synechiæ; ophthalmoscopic illumination. The markings of the iris are not well defined; the synechiæ show dark, forming the characteristic clover-leaf pupil.

FIG. 2.—Exclusion of the pupil or total posterior synechiæ from chronic iritis; ophthalmoscopic illumination. The whole edge of the iris and sometimes the entire posterior surface of the iris are bound down by adhesions to the anterior capsule of the lens; this condition and the following (Fig. 3) are prone to give rise to secondary glaucoma.

FIG. 3.—Occlusion of the pupil from iridocyclitis; oblique illumination. The pupillary area is filled with organized exudation; the pupillary margin of the iris being bound down to the anterior capsule of the lens, the centre of the iris being bulged forward, causing the condition known as iris bombé.

FIG. 4.—Iridodialysis (ophthalmoscopic illumination), forming two pupils and associated with double vision. This condition and that of the next are of traumatic origin.

FIG. 5.—Polycoria; ophthalmoscopic illumination. In this patient there were three pupils and triple vision; the edge of the lens and ciliary processes could be distinctly seen.

FIG. 6.—Foreign body in iris and lens, binding the iris down to the lens; this being aseptic, was not associated with inflammatory changes, and was retained in the eye ten days before extraction by the magnet; but slight opacity of the lens capsule followed. Direct illumination.

FIG. 7.—Anterior synechia with hernia of the iris from incarceration in corneal wound. Direct illumination.

FIG. 8.—Sarcoma of the iris; oblique illumination. This was attended by iritis and posterior synechia.

FIG. 9.—*Syphilitic iritis*; direct illumination. Gumma of the iris.

which form in small dots in the shape of a pyramid, with the base at the lower part of the cornea and the apex near the centre. It is supposed to assume this shape because the direction of the intraocular fluids is through the pupil toward the angle of the anterior chamber, the fibrinous deposits falling, to a certain extent, on account of gravity. The aqueous humor is turbid, and vision is usually greatly impaired. There are posterior synechiæ, and the pain accompanying this form of iritis may be comparatively mild, or very severe. There is a marked tendency to increase of the intraocular tension and the production of secondary glaucoma. The disease is more common in women than in men, and is sometimes observed to accompany menstrual and pelvic disorders. It may occur as a rheumatic or a syphilitic iritis, the name having reference purely to the form of exudate observed.

Parenchymatous iritis is an inflammation of the deeper structures or of the parenchyma of the iris. The swelling may be extensive, occupying the whole of the iris, or it may be circumscribed and look as if there were several nodules in the iris tissue. The exudate into the substance of the iris may become purulent, accompanied by closure of the pupillary space and the formation of hypopyon, a condition known as *suppurative iritis.*

Etiologically, we also have many varieties of iritis, among which are the following:

Syphilitic iritis is any form of iritis which has syphilis as its cause. It may appear in the plastic, serous, or parenchymatous form. It is sometimes very difficult to determine the cause of iritis, particularly of the syphilitic variety, and it becomes necessary, in the absence of a history of syphilis, gout, or rheumatism, to determine the diagnosis by the employment of antisyphilitic remedies. It is impossible after making an examination of a plastic or serous iritis to state that the cause was syphilis. There is one form of syphilitic iritis, however, which is pathognomonic; this is the so-called *gummatous iritis* (see Plate V., Fig. 9), of which two forms are described. The first,

referred to by some authors as *iritis papulosa*, consists in the formation of nodules in the substance of the iris tissue, which are at first small, and may appear in the inner zone of the iris in the neighborhood of the margin of the pupil, at the ciliary border, or in between the two. The nodules may be multiple or single, and may also be small, or cover a considerable surface of the iris. They are usually of a dusky red color, crossed by small vessels, and slightly elevated above the surface of the iris. This form is found in the secondary stage of syphilis, and is not common. A true gumma of the iris is of large size, becomes somewhat pale at its apex, and is found in the gummatous stage of syphilis.

There is but one form of iritis that might be confounded with the gummatous form occurring in syphilis, and that is *tubercular iritis.* This variety of iritis, however, is subacute. The tubercular elevations do not appear first at the margin of the pupil, are not so red, and are not accompanied with such marked congestion of the iris. In the syphilitic form the perivascular injection is very pronounced; in the tuberculous form it is very slight. Syphilitic iritis is usually accompanied with very great pain, which is worse at night.

According to different authorities, from about 0.5 to 5.5 per cent. of all cases of syphilis are affected with iritis during the course of the disease; in from 30 to 60 per cent., however, of all cases of iritis, syphilis is found to be the cause.

Rheumatic and gouty iritis is any form of iritis which has rheumatism or gout as its cause. It may occur either in the plastic or serous form, though the former is the more frequent. It is more frequently seen in men than in women, and, as a rule, one eye is affected; the second eye, however, becomes affected at a later period. Relapses are very apt to occur, so much so that the name *recurrent iritis* has been given to some varieties. There is a form of iritis, usually rheumatic in character, to which the name *quiet iritis* has been given, in which there

is no pain or ciliary congestion, the principal symptom being a gradual diminution of visual acuity. It is to be borne in mind, however, that this affection may also be produced by syphilis.

Diabetie Iritis. Patients who are affected with diabetes occasionally develop a plastic iritis either following an operation or independent of any traumatism. It is usually complicated with hemorrhage into the anterior chamber, and is very stubborn in character.

Gonorrhœal iritis is a form of iritis usually of a plastic character, which comes on some time after the gonorrhœal attack, an inflammation of one of the joints having intervened. It is accompanied by severe pain and the ordinary symptoms of iritis.

Infectious disease iritis is sometimes found in association with various diseases, as recurrent fever, pneumonia, cerebro-spinal meningitis, influenza, typhoid fever, etc.

Secondary iritis is that variety which appears as a consequence of a pre-existing disease of the eye. It is seen, for example, to accompany disease of the cornea or scleritis.

Traumatic iritis results from an injury, which may be accidental or produced by an operation.

Idiopathic iritis is that variety in which no injury or disease can be found as a cause. It is usually confined to one eye.

Chronic iritis is a variety of iritis which assumes a chronic course. There are no additional symptoms which do not appear in acute iritis, but these symptoms are ordinarily modified by the chronic course of the disease.

Diagnosis. The two diseases most frequently mistaken for acute iritis are *acute catarrhal conjunctivitis* and *acute inflammatory glaucoma.* The differentiation from the latter will be taken up in the discussion of that disease. The following table will assist in the differentiation from conjunctivitis :

ACUTE IRITIS.	ACUTE CONJUNCTIVITIS.
1. Conjunctival injection most marked near the cornea.	1. Conjunctival injection least marked near the cornea.
2. Cornea more or less hazy; markedly so in serous iritis.	2. Cornea clear.
3. Contracted pupil with posterior synechiæ.	3. Pupil normal.
4. Iris discolored and the surface irregular.	4. Iris unaffected.
5. Aqueous humor frequently turbid.	5 Aqueous humor unaffected.
6. Conjunctiva usually translucent.	6. Conjunctiva opaque.
7. Some tenderness upon pressure.	7. Tenderness not marked.
8. Severe pain, worse at night, referred to the brow or temple.	8. Very little pain, and, if present, referred to the eye itself.
9. Dimness of vision.	9. Vision not affected.

Acute iritis may be differentiated from *interstitial keratitis* by the character of the corneal haze, the course of the affection, and the accompanying stigmata, which are usually found in the latter disease.

Prognosis. This depends upon the severity of the disease, the cause, the presence of complications, and the treatment. If the synechiæ are few and treatment is begun early, it is probable that the attack will be short. Syphilitic cases clear up very well, as a rule, unless the deeper structures of the eye are affected. The rheumatic and gouty varieties are slower in their progress, and present numerous recurrences. If some of the synechiæ should remain after an attack the liability to recurrence is greater than if these were not present.

Complications and Sequelæ. As complications of iritis the inflammatory process may extend to the cornea, the ciliary body, the choroid, the vitreous, the optic nerve, and the retina.

After an attack of iritis there may be complete or partial attachment of the iris to the capsule of the lens which did not disappear under treatment. There may also be a deposit of exudate in the pupillary space and upon the capsule of the lens, so that vision is practically abolished. If the synechiæ are annular in character and the pupillary space is filled with exudate, in a short time the secretions from the posterior chamber cause the iris to bulge forward

and produce the condition known as *iris bombé*. (See Fig. 62 and Plate V., Fig. 3.) If the pupillary space is filled with exudate the condition is termed *occlusion of the pupil.* (See Plate V., Fig. 3.) If the iris is firmly attached in its whole circumference, the pupil remaining clear, it has been called *exclusion of the pupil.* (See Plate V., Fig. 2.)

Treatment. In the treatment of iritis there are several indications which must be considered. It is necessary as early as possible to break down any adhesions between the iris and the anterior capsule of the lens, and to prevent them from re-forming by maintaining constant mydri-

FIG. 62.

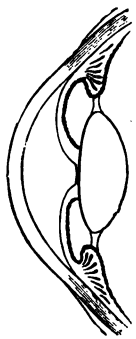
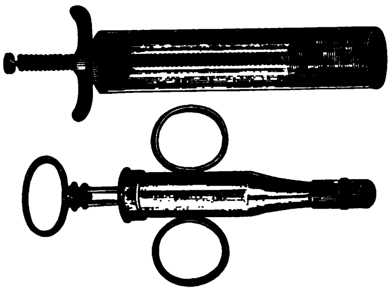


Diagram to show the result upon the iris of exclusion of pupil. (From a specimen.) (Nettleship.)

asis. For this purpose some one of the stronger mydriatics is employed, the one most commonly used being atropine. In a few cases this mydriatic produces a marked inflammation of the lids and conjunctiva, so that some other has to be substituted. In these cases a solution of hydrobromate of hyoscine, or a solution of sulphate of duboisine, will often be borne without the disagreeable results of solutions of atropine. A solution of scopolamine may be employed in very mild cases in which prolonged mydriasis is not required. The mydriatic should be instilled at frequent intervals until mydriasis is obtained, when it should

be continued three or four times a day. The mydriatic effect of any of these solutions may be increased by preceding each instillation by the instillation of a drop of a 4 per cent. solution of cocaine. The patient should wear a pair of smoked glasses, and, if photophobia is severe, confinement in a moderately dark room for a few days may be required. The pain may be combated by the use of hot fomentations to the eye. These will also aid in promoting the action of the mydriatic in causing dilatation of the pupil. The use of the mydriatic and of the hot fomentations may be sufficient to allay the pain, but if these do not suffice, or if there is marked congestion of

FIG. 63.



Heurteloup artificial leech

the eyeball, blood should be abstracted from the temple by means of leeches, either natural or artificial. If the natural leeches are employed, they are applied in the following manner:

The skin of the temple immediately back of the angle of the eye in men or at the hair line in women, as the leech bite produces a minute scar, is the position for their application. The surface is thoroughly cleansed with soap and water, and the leech, contained in an ordinary leech-glass or in a cylinder of paper, is permitted to become attached to the skin. If it refuses to take hold, a minute prick of the skin, permitting the escape of a drop of blood, will cause it to do so. Two or three Swedish leeches,

or twice this number of American leeches, should be employed. More blood can also be abstracted by continuous bathing with warm water after the leeches have filled themselves and dropped off. The surface should then be washed with an antiseptic lotion and pressure applied to stop the bleeding. After leeching, the patient usually experiences great comfort, and enjoys a refreshing sleep.

If these means do not suffice to relieve the pain the administration of some drug is called for. For this purpose most of the analgesics have been employed, and $\frac{1}{100}$ grain of the hydrobromate of hyoscine at bedtime, is highly recommended. Subconjunctival injections of a few minims of physiological salt solution sometimes prove of great service in relieving the symptom and preventing its recurrence *In making a subconjunctival injection* the eye is first made anæsthetic by a few drops of holocaine or cocaine, after which the surgeon, standing behind the patient, separates the lids with the thumb and forefinger of the left hand, and pricks the conjunctiva with the needle of a hypodermic syringe held in the right hand. The injection should be made from 6 mm. to 8 mm. distant from the corneal margin, after which the eyelids are closed and a slight rubbing movement made with a pledget of absorbent cotton so that the salt solution may be dispersed.

Constitutional Treatment. The cause of the disease must be ascertained and the appropriate constitutional treatment administered. In all varieties of iritis the employment of mercury for its constitutional effect seems to be useful. This may be obtained either through the administration of mercurial ointment by inunction, a drachm being employed night and morning, or by the administration of calomel in small doses, $\frac{1}{8}$ to $\frac{1}{4}$ of a grain being given four times a day for several days. If syphilis is the cause, the mercurial treatment must be continued; and if there is much exudate, or the iritis is gummatous in character, large and rapidly increasing doses of the iodides must be given. If some other cause has produced

the iritis, the remedies appropriate to that particular cause should be administered. In rheumatic iritis, the salicylates, salicine, and aspirine; in gouty iritis, some form of colchicum, together with restricted diet; in diabetic iritis, appropriate diet and the treatment of the diabetic condition; in gonorrhœal iritis, mercury, the iodides, and pilocarpine sweats; in tubercular iritis, an iridectomy may be performed if all the tuberculous tissue can be removed; if this cannot be done, the entire globe must be enucleated. In scrofulous iritis, the administration of cod-liver oil and the iodide of iron; in infectious disease iritis, and secondary iritis, the treatment of the affection giving rise to the inflammation; in traumatic iritis, if seen early, the application of cold compresses, and internally small doses of calomel.

In the treatment of serous iritis, mydriatics must be very cautiously employed, as there is a marked tendency to secondary glaucoma. If the latter should arise, the mydriatics must be at once stopped, and if the intraocular tension does not subside it may be necessary to perform a paracentesis of the anterior chamber, or even an iridectomy. If there is much exudate following serous iritis pilocarpine sweats are of great service. In recurrent iritis, after several attacks, or after an occlusion of the pupil, it may be necessary to perform an iridectomy to prevent the recurrence, or for optical purposes.

Tumors of the Iris. The most frequently found primary tumor of the iris is *sarcoma*. (See Fig. 64 and Plate V., Fig. 8.) It may be pigmented, or non-pigmented, and may originate from any portion of the iris tissue. Primary sarcoma of the iris occurs twice as frequently in females as in males, each eye seems to be equally predisposed, and the favorite position seems to be in the lower half, and especially in the lower outer quadrant of the iris. It is more frequently found in patients whose ages range between twenty and forty years. *Melanoma* of the iris is a dark tumor developed from the pigment layer, and is sometimes the starting point for sarcoma.

Cysts and *tubercles* are also occasionally found primarily in the iris. *Gumma* of the iris does not differ from gumma elsewhere. It is usually accompanied by more

FIG. 64.

Primary sarcoma of the iris, removed by iridectomy. No recurrence seven years later.

acute inflammatory symptoms than is the case in sarcoma. It is usually of a yellowish-white color, with blood-

FIG. 65

Dermoid tumor of the iris. (Würdemann).

vessels crossing over its apex, and with an inflamed base. Should there be any doubt, the administration of antisyphilitic remedies will determine the diagnosis.

Treatment. If the growths of the iris are sufficiently small to be removed by an iridectomy, this procedure should be adopted. If, however, this cannot be done, and the growth is malignant in character, the eyeball must be enucleated.

Congenital Anomalies. **Heterophthalmos** is that condition in which one iris differs from the other in color. It is without any pathological significance, but is stated to occur more frequently in nervous individuals.

Coloboma of the Iris. This is a fissure looking somewhat like an imperfectly performed iridectomy. (See Plate VI.) It may occur in one or both eyes, and if in one eye, is usually found in the left. Its most frequent situation is downward, or downward and inward, and it is due to

FIG. 66.

Remnants of pupillary membrane. (Randall.)

imperfect closure of the choroidal fissure during fœtal life. The sphincter of the pupil is usually continued along the pupillary edge of the coloboma. Coloboma of the iris is occasionally associated with a similar defect in the lens and choroid.

Corectopia is a name which has been given to an eccentric position of the pupil. It may affect both eyes symmetrically, and may also occur in several members of the same family.

Polycoria is a term which has been used to describe a condition in which there are a number of pupils. These may be situated very near the normal pupil, and separated from it and from each other by narrow strips of iris tissue. (See Plate V., Fig. 5.)

PLATE VI.

Double coloboma of iris and lens (congenital); ophthalmoscopic illumination.

Persistent Pupillary Membrane is the result of an incomplete disappearance of the membrane which is found on the anterior surface of the lens in fœtal life. *Capsulo-pupillary membrane* is the portion of a persistent pupillary membrane extending from the capsule of the lens to the iris, and may be mistaken for the posterior synechia of iritis.

Irideremia (**Aniridia**) is a congenital absence of the iris, and is usually accompanied by a diminution of vision, nystagmus, and congenital opacity of the lens or cornea. It may be complete or partial, and affects one or both eyes.

Congenital Ectropion of the Uvea is a projection of a round mass of the uveal layer around the margin of the pupil to the anterior portion of the iris.

DISEASES OF THE CILIARY BODY.

Cyclitis is a term which is applied to inflammation of the ciliary body, and is either plastic, serous, or purulent in character. It usually exists as part of a general inflammation of the uveal tract, or uveitis, but is occasionally found as a separate disease in that the ciliary body is that portion of the uveal tract most affected. In this disease there is deep pericorneal injection and severe pain, which may be referred to the temple and side of the head. Upon making palpation of the ciliary region through the lids great tenderness is observed, and the patient shrinks from the touch of the surgeon. There is marked photophobia and lacrymation, and also considerable impairment of the visual acuity on account of exudate in the anterior chamber, pupil, and vitreous.

It is customary to divide cyclitis into three varieties, *plastic*, *serous*, and *purulent*.

Plastic Cyclitis is a form of inflammation of the ciliary body in which an exudate of plastic lymph is thrown out which usually forms a layer in the anterior portion of the vitreous behind the lens. This exudate

sooner or later becomes organized and takes on the form of cicatricial connective tissue. In certain cases this membrane forms a firm partition between the lens and the posterior parts of the eye. Examination with the oblique method discloses a grayish mass back of the lens, situated at its periphery when the membrane is not complete. There is considerable congestion of the iris, which is sometimes retracted by the exudate in the ciliary body, producing slight dilatation of the pupil and increase in the depth of the anterior chamber. The inflammation may extend to the iris in front and to the choroid behind, producing a general uveitis.

Serous Cyclitis is characterized by a moderate pericorneal injection and a lack of severe pain, except in rare instances. There is tenderness in the ciliary region, photophobia, lacrymation, and diminution of visual acuity. There is also a deep anterior chamber, somewhat turbid aqueous humor, a moderately dilated pupil, vitreous opacities, and a decided tendency to an increase of the intraocular tension. There are also a number of punctate deposits on Descemet's membrane arranged in the shape of a triangle, with its base toward the lower periphery of the cornea, and its apex toward the centre, and on account of which various names have been employed for this condition, viz., *serous iritis, keratitis punctata*, and *Descemetitis.*

Purulent Cyclitis is usually found as the result of infection, either by means of an ordinary wound, or as the result of an infected ulcer of the cornea. The ciliary pain is marked, and there is very great pericorneal injection, together with swelling of the eyelids and some chemosis of the conjunctiva. The vitreous and aqueous humors become turbid, and pus appears in the anterior chamber. There is a tendency to an increase of the intraocular tension and to an extension of the disease, the iris and choroid frequently participating in the inflammatory process.

Causes. The most frequent constitutional affections that produce cyclitis are rheumatism and syphilis. It is

usually an extension of an inflammatory process which involves the choroid or iris. Traumatism, either accidental or operative, is, perhaps, the most frequent cause of its production. The entrance of a foreign body into the eye, or a lacerated or punctured wound, carrying minute germs of infection, suffice to produce the disease.

Course. The course of this affection is very tedious, although any variety of cyclitis may terminate in the re-establishment of useful vision under prompt and energetic treatment.

Prognosis. This is always very grave because there is not only the probability of an attack of secondary glaucoma, but also a tendency to atrophy of the iris and choroid, or even a condition of shrinking of the eyeball, known as *phthisis bulbi.*

Treatment. The treatment of cyclitis is practically the same as that described for iritis, except that greater caution must be employed in the use of mydriatics. Inasmuch as there is a marked tendency to the formation of exudate with attachment of the iris, it is better to employ some mydriatic to produce mydriasis unless there should be an increase of the intraocular tension. The mydriatic, however, must be used very cautiously, and if the tension should at any time become increased, it must be discarded. Because of this marked tendency to secondary glaucoma it is perhaps better to use the mydriatics whose action is of short duration, such as scopolamine, duboisine, and hyoscyamine.

Tumors of the Ciliary Body. The same variety of tumors that are found in the iris are also observed to have their origin in the ciliary body. *Sarcoma* usually appears first as a brownish mass behind the iris. In malignant growths the eyeball must be removed as soon as possible.

SYMPATHETIC IRRITATION AND SYMPATHETIC INFLAMMATION.

These are terms which have been employed to describe affections occurring in one eye as the result of disease or injury to the other. The conditions represented by these terms are entirely different. The eye in which the disease or injury has occurred, which gives rise to the affection in the opposite eye, is known as the *exciting* eye; the eye secondarily affected is known as the *sympathizing* eye.

Sympathetic Irritation is an affection, functional in character, the symptoms of which are slight photophobia, lacrymation, diminished visual acuity and accommodation, together with inability to employ the eyes for close work except for a short time. There may also be slight neuralgic pain, photopsia, some contraction of the visual field, and hyperæmia of the fundus. In some cases a slight tenderness is observed when pressure is made over the ciliary region, and there is a marked tendency for the attacks to recur. In a patient who is subject to recurring attacks of sympathetic irritation there are commonly attacks of ciliary congestion, photophobia, tenderness, lacrymation, and neuralgic pain in the exciting eye during the attack of irritation in the sympathizing eye.

The condition disappears entirely with the removal of the eye which is productive of the disease.

Sympathetic Inflammation (Sympathetic Ophthalmitis) may occur in one of several forms, and may follow an attack of sympathetic irritation, or occur without any previous symptom of this character. The disease usually manifests itself in one of three ways, viz., as a *plastic iridocyclitis*, as a *serous iritis*, or as a *choroido-retinitis*. The patient at first may experience some difficulty in use of the eyes, slight dimness of vision, or neuralgic pain in the region of the temple. These symptoms may gradually increase and become more marked until very little

vision is left. The first objective sign is oftentimes slight pericorneal injection. If pressure is made over the ciliary region it produces pain. When the disease appears as a choroido-retinitis, an ophthalmoscopic examination of the eyeground will reveal a commencing papillitis, together with some œdema of the retina and dilated and tortuous retinal veins. In the greater number of cases, however, the first evidence of inflammation in the interior of the eye is observed in the iris, which is sometimes discolored in appearance. The pupil is contracted, and posterior synechiæ form at an early date. With the formation of the posterior synechiæ there is also an exudation of plastic material, the aqueous becomes somewhat turbid, and the iris is swollen and thrown into folds. At this stage, the fundus of the eye cannot be distinctly seen because of punctate opacities on the posterior surface of the cornea usually found in serous iritis and cyclitis, as well as opacities in the aqueous and vitreous humors. Pericorneal injection becomes more marked, pain increases, and the disease goes on to the production of permanent blindness. In some cases there is iritis or iridocyclitis, some congestion of the eyeball, and alteration in the tension of the exciting eye preceding the actual development of sympathetic inflammation ; but these conditions are not always present.

Causes. Sympathetic inflammation is a diseased condition produced in a previously healthy eye on account of some injury or disease which has partially or totally destroyed the fellow eye. The most frequent cause is some injury to the ciliary region whereby some infectious material has been carried into the eye and has there set up an inflammatory process, usually in the nature of an iridocyclitis. It is because injuries to the ciliary region are very apt to produce sympathetic trouble that this portion of the eye has been termed the *danger zone.* It must be borne in mind, however, that infected wounds in any part of the eyeball may bring about this condition. Suppurative diseases of the eye result in total destruction,

but seldom produce sympathetic ophthalmia. The disease sometimes follows operations for iridectomy and for the removal of a cataractous lens.

The Period of Incubation between the time that the exciting eye receives the injury and the actual development of sympathetic inflammation varies greatly, but in the majority of cases is from three to six weeks. It may begin earlier, however, and has been observed after a period of many years.

The Pathogenesis of sympathetic inflammation has not been definitely determined. Formerly it was thought that the inflammation was produced by means of the ciliary nerves and that it was purely a sympathetic process. More recently it has been advocated that infectious material is carried from the exciting to the sympathizing eye by means of the optic nerve sheaths, and that this infectious material is in the nature of some micro-organism. This theory, however, has not yet been proven.

The Prognosis of sympathetic inflammation is very bad, even when the case comes under observation in the earliest stage. The course of the disease is long and tedious, and most frequently results in loss of vision in the sympathizing eye. Occasionally when the pupil has been completely closed as the result of sympathetic inflammation, some useful vision may be obtained by performing an operation to make an artificial pupil.

Treatment. The most important treatment of sympathetic ophthalmia is the *prophylactic;* and prophylaxis consists in the removal of an eye which is likely to give rise to sympathetic inflammation before it has had the opportunity to do so. For this reason enucleation, or one of its substitutes, should be performed,

1. If an eye has been injured in the ciliary region and vision hopelessly destroyed.

2. If an eye has been so severely injured in the ciliary region that vision will ultimately be destroyed by inflammation.

3. If the eye contains a foreign body which it is impossible to remove, and an iridocyclitis is present.

4. If there is sympathetic irritation as the result of a shrunken, phthisical eyeball which at times shows tenderness on pressure, or which has resulted from traumatism.

5. The exciting eye, if blind, should be removed if sympathetic inflammation has already manifested itself; if the exciting eye retains some vision, however, it should never be removed, as it may be the better of the two after the inflammatory process subsides.

It is impossible to give any rules for the removal of an injured eye to which no exception shall be made, as it is a well-recognized fact that by the application of conservative methods of antiseptic surgery many badly injured eyes are preserved with useful vision that would have been formerly sacrificed. If an eye has received a severe injury, but the vision is not destroyed, and the patient can be kept under observation during the period of incubation, it is well to attempt to save it by conservative treatment. If the patient cannot be kept under observation, or if a severe iridocyclitis threatening the loss of useful vision should come on as a result of the injury, it is better to enucleate the eye before sympathetic trouble manifests itself. It should be borne in mind, however, that early removal of an injured eye does not always prevent sympathetic trouble, because the infective process may have begun before removal of the exciting eye, and not necessarily develop for several weeks. Instead of enucleation, evisceration, either with or without the implantation of an artificial vitreous, may be employed in those cases in which the operation is performed before any inflammatory process has begun. Evisceration should not be performed, however, after sympathetic inflammation has made its appearance.

The treatment for the sympathizing eye does not differ from that treatment which would be given under similar conditions independent of sympathetic trouble. Protection of the eyes from strong light, frequent instilla-

tions of a solution of atropine, hot fomentations, and the abstraction of blood by means of leeches, are indicated. Mercury in some form, if the patient is not much run down, together with the free administration of the iodides are of benefit. If the patient is much debilitated, tonics and stimulating treatment are called for. Subconjunctival injections of solutions of bichloride or cyanide of mercury have been advocated by some surgeons.

After a considerable period of time the affected eye will either recover with some useful vision, or will become atrophied with complete closure of the pupil, and, perhaps, a cataractous lens. No operation should be attempted upon eyes of this character until several months have elapsed since the subsidence of the inflammatory process, when an attempt may be made to improve the vision by an iridectomy or an iridotomy.

Enucleation of the Eyeball. In enucleating the eyeball there are two methods in general use, viz., Bonnet's method and the Vienna method.

Bonnet's Method. The instruments required are a pair of small blunt scissors, a pair of larger and stronger scissors for division of the optic nerve, fixation forceps, a strabismus hook, and a speculum. (See Tenotomy of an Ocular Muscle.) The speculum having been introduced beneath the lids in order that they may be separated, the eye is seized with the fixation forceps, and the conjunctiva and adjacent tissue are divided from their attachment around the cornea. This is sometimes called "circumcising" the cornea. Each muscle is then in turn picked up with the strabismus hook and divided at the point of its tendinous attachment to the sclera, with the exception of the internal rectus, which is divided somewhat back of its insertion in order to leave a stump that can be used for rotating the eyeball. Seizing this stump with the fixation forceps and rotating the eye outward as far as possible, the large scissors, closed, are passed backward behind the eyeball from the nasal side, and as soon as the optic nerve is reached, are opened and passed one blade below,

and the other above the nerve which is divided close to the eyeball, or deep in the orbit, as may be required. The globe of the eye is now dislocated forward between the lids, and any remaining attachments severed.

The Vienna Method. The instruments required in this method are a strong pair of scissors, fixation forceps, and a speculum. The tendon of the internal rectus muscle is seized with the conjunctiva and adjacent tissue and held during the entire operation. With the strong scissors it is divided back of the forceps. Then the scissors are passed around the entire eyeball, one blade beneath the conjunctiva and muscles, the other on the outside, when by numerous cuts the muscles and conjunctiva are separated from the globe at the same time. The latter is now rotated outward and the optic nerve divided as in the preceding operation. (For dressings and after-treatment see Chapter XIX.)

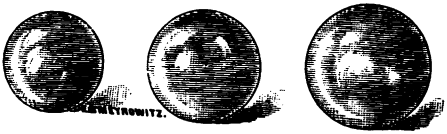
A modification of the operation of enucleation of the eyeball consists in attaching the recti muscles to the overlying conjunctiva before they have had an opportunity to become retracted into the tissues of the orbit. It has been shown that without this the muscles will retract about 1 cm.; therefore, by suturing them to the overlying conjunctiva this retraction is prevented and a better stump is obtained. The tendons may be attached to the conjunctiva by passing a suture beneath them before they are separated from the sclera, or afterward. The edges of the conjunctiva are also approximated by means of a few sutures.

Evisceration of the Eyeball. Two methods of evisceration are employed at the present time, viz., the one suggested by von Graefe, the other suggested by Mr. Mules.

Von Graefe's Method. The instruments employed are a Graefe cataract knife (Fig. 99), fixation forceps (Fig. 103), a pair of curved scissors (Fig. 125), a scoop, a speculum (Fig. 105), needles, needle holder (Fig 178), and silk. The conjunctiva is first dissected loose from the corneal

margin with a pair of curved scissors. The Graefe cataract knife is then entered at the corneo-scleral junction, passed directly across the anterior chamber, the counter-puncture being opposite the point of entrance, and a flap made separating the upper half of the cornea from the sclera. The remaining half of the cornea is then detached with scissors. With the scoop the contents of the globe are thoroughly evacuated, care being exer-

FIG. 67.



Glass spheres for Mules' operation.

cised to remove every portion of the choroid and ciliary bodies. The sclera and conjunctiva are then sutured either separately or together.

Mules' Operation. To provide a stump for an artificial eye, even better than the one resulting from the preceding operation, the following measures have been suggested by Mr. Mules: The conjunctiva is first detached from

FIG. 68.

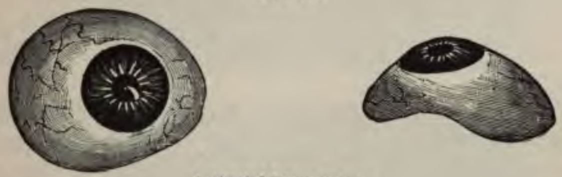
Introducer for Mules' spheres.

the corneal margin with a pair of curved scissors. The cornea is then removed and the contents of the globe evacuated, precisely as in the preceding operation. By making a snip with the scissors above and below, the opening in the globe is enlarged vertically. One of Mr. Mules' globes (Fig. 67), made of glass or gold, is now introduced by means of an instrument devised for the purpose (Fig. 68), or by the fingers, and the sclera

sutured from side to side. The overlying conjunctiva is then sutured from above downward at right angles to the line of scleral sutures.

Artificial Eyes. After the operation of enucleation or evisceration in any of their various forms an artificial eye is to be worn over the stump thus prepared. It should match the fellow eye in color and be of sufficient size to fill the cavity created by the removal of the natural eye. It should also be left out every night, and the socket frequently irrigated with some cleansing lotion otherwise it will become very sore. The artificial eyes are usually fitted three or four weeks after the eye has been removed.

FIG. 69.



Artificial human eyes.

Resection of the Optic Nerve. An opening is made in the conjunctiva slightly back of that portion lying over the insertion of the internal rectus muscle. The conjunctiva is then dissected well backward, and the muscle exposed as completely as possible. Sutures are now passed through the muscle back of the tendon, in order to secure it, and the muscle is divided about 5 mm. or 6 mm. from its tendinous insertion. With a retractor the tissues are now pulled aside and a hook is passed beneath the optic nerve, which is drawn forward and divided as far back as possible with the strong curved scissors. A piece of the nerve is then excised from the globe of the eye, when the muscle is re-attached by means of the sutures and the conjunctival opening is closed.

CHAPTER VIII.

DISEASES OF THE CHOROID.

Choroiditis is a term employed to describe several varieties of inflammatory conditions which occur primarily in the choroid. It must be borne in mind, however, that on account of the proximity of the retina the latter membrane is, as a rule, secondarily involved. The two principal divisions of choroiditis are *non-purulent* (*exudative*) and *purulent*.

Non-purulent Choroiditis (**Exudative Choroiditis, Plastic Choroiditis**). Under this heading are described the symptoms which are applicable to most of the cases of non-purulent choroiditis before discussing the special features of the different varieties.

Symptoms. There is considerable disturbance of vision, depending entirely upon the situation and extent of the inflammatory process. If the vitreous has become secondarily involved the reduction of visual acuity is very great. In the earlier stages objects may appear distorted or changed from their natural size, in some instances appearing too small, and in other instances too large. There may also be photopsia, or flashes of light before the eyes. There may be scotomas of the visual field, together with some contraction.

Externally there are no signs of the inflammatory process which is going on within. With the ophthalmoscope can be seen localized patches which make the surface of the eyeground appear uneven and more or less opaque. If the patches of inflammation are recent they appear buff colored or grayish, and present no well-defined

PLATE VII.

Fig. 1.

Fig. 2.

Fig. 1. Chronic disseminated choroiditis. (Würdemann, after Oeller.)
Fig. 2. Diffuse choroiditis with partial atrophy of retina and optic nerve. (Würdemann.)

edges. At a later stage absorption of the exudate may have taken place, producing an area of atrophy. If the atrophied patch is superficial it will appear buff colored, and the choroidal vessels will be distinctly seen. If, however, it is deep it will be whitish in appearance on account of the sclera beneath, and there will be considerable pigment-heaping along its edges. This pigment may be brownish or black in color, and present numerous shapes. If the retinal vessels can be seen they are observed to lie in front of the pigment or atrophied patches. Very frequently the vitreous will show involvement, when it becomes quite turbid.

Causes. Choroiditis is frequently associated with inflammation of the iris and ciliary body, so that any cause that would give rise to these inflammations would also produce a choroiditis. The most frequent cause is syphilis, which may be either acquired or hereditary. It may also be found in constitutional disorders where the nutrition is impaired and the patient is anæmic. Traumatism and disorders of the menstrual function will also produce the disease. Choroiditis is also found in high myopia, but it is probable that the changes are more of a degenerative than of an inflammatory type, and are due to the stretching of the choroid.

Varieties of Choroiditis. Many varieties of choroiditis have been described, each possessing some symptom or symptoms peculiar to itself.

Thus, in **disseminated choroiditis** (see Plate VII., Fig. 1) a number of round or irregular-shaped spots are observed scattered throughout the fundus. The course of this variety is very chronic, and the vision may remain good unless the macular region is involved. The cause of this variety is most frequently acquired or inherited syphilis.

Serous Choroiditis is that variety characterized by marked haziness of the vitreous, which contains numerous small floating opacities. It is frequently accompanied by slight congestion of the anterior portion of the eyeball and

slight pain. There is some tendency to increase of the intraocular tension.

Central Choroiditis is a variety in which the changes are found principally in the macular region, and is most frequently seen in very high myopia. It may, however, occur as the result of senile changes, when it is called *senile choroiditis*. (Fig. 70 and Plate VIII., Fig. 1.)

Diffuse Choroiditis (Plate VII., Fig. 2) occurs as one or several large areas in which the exudate is extensive, and which is usually followed by atrophy. It is accompanied by extensive pigment patches.

FIG. 70.

Central choroiditis. (De Wecker and Jaeger.)

In **Tubercular Choroiditis** there are a number of small miliary tubercles surrounded by some haziness and œdema of the retina situated in the neighborhood of the optic nerve and the macular region. They are found in the course of acute miliary tuberculosis and tubercular meningitis, and the condition may also present itself as a single tuberculous area which is usually situated in the macular region and which may be mistaken for glioma

PLATE VIII.

Fig. 1.

Fig. 2.

Fig. 1. Central senile choroiditis. (Würdemann.)
Fig. 2. Posterior staphyloma and rupture of choroid. (Würdemann.)

of the retina. With the ophthalmoscope a small reddish point in the fundus of the eye is the first thing that can be observed. Later these points present a whitish appearance at their centres, and are distinctly elevated. The tubercular areas are found in the anterior layers of the choroid, and treatment is of little use.

Myopic Choroiditis occurs as an atrophy of the choroid in cases of progressive myopia of high degree. As the eyeball becomes elongated there is bulging of the sclera at the posterior pole of the eye and an atrophy of the choroid in the neighborhood of the optic nerve, usually beginning on the temporal side. Sometimes this has been called *posterior sclerochoroiditis, posterior staphylomata,* and *semiatrophic crescents.* (See Plate VIII., Fig. 2.) There may be many changes in the macular region characterized by numerous fine lines which gradually coalesce and form an atrophic area bordered more or less with pigment. It is necessary in this variety of choroidal inflammation to regulate the habits of the patient as regards the use of the eyes and to encourage outdoor life, with as little close work as possible.

Diagnosis of Choroiditis. This can only be made by means of an ophthalmoscopic examination of the eye-ground, when the various objective symptoms previously described may bè observed. As a rule, there are changes in the retina as well as in the choroid, and it is often difficult to determine positively whether the exudates which are found lie in one membrane or in the other. When the exudate lies in the choroid, however, the course of the retinal vessels can usually be distinctly followed. The exudate in the choroid also presents a more yellowish appearance, is not so opaque, and lies much deeper than if seen in the retina.

Prognosis of Choroiditis. Unfortunately the patches of choroiditis usually pass into a state of atrophy, and opacities remain in the vitreous, notwithstanding treatment. The prognosis as to the impairment of vision is naturally much worse when the macular region or its immediate

neighborhood is involved. The cases in which syphilis is found to be the cause and which come under treatment early, probably offer the best prognosis.

Treatment of Choroiditis. Complete rest of the eyes must be obtained by the instillation of atropine or some other mydriatic, provided the anterior portion of the uveal tract is in the least involved. The eyes should not be used for any near work, and bright light should be avoided. The wearing of smoked glasses will assist in protecting the eyes from the light. In the early stages the application of a few leeches to the temple or to the skin behind the mastoid process seems to be of benefit, if the patient is plethoric. The administration of mercury and the iodides is demanded if any syphilitic history can be obtained, and even in the absence of syphilis they frequently do good. Profuse sweating by means of hypodermic injections of pilocarpine are of benefit, especially in those cases with involvement of the vitreous. If the patient is debilitated, tonics, cod-liver oil, nourishing food, and good hygiene are to be recommended. Subconjunctival injections of bichloride of mercury have been advised, but do not seem to be of much value.

Purulent Choroiditis (Suppurative Choroiditis, Panophthalmitis, Iridochoroiditis). As the name implies, this affection consists of a suppurative process involving the choroid; but, as a rule, it is almost never confined to this membrane. The whole uveal tract, as well as the retina and vitreous, usually becomes involved in the process.

Causes. Purulent choroiditis results from traumatism, or as a result of metastasis from a similar process taking place in some other portion of the body, frequently in the membranes of the brain, or in the genital tract. It may also result by metastasis from erysipelas, septic endocarditis and other forms of pyæmia, influenza, etc. If it occurs as a result of traumatism the germs of suppuration are directly introduced, and this is the case when

the affection is found after operations upon the eye, or as the result of a sloughing ulcer of the cornea.

Symptoms. Occurring as the result of traumatism the progress is usually rapid. The ocular conjunctiva becomes markedly congested and œdematous, producing compression around the corneal limbus. Reflected light from the eye gives the appearance of a yellowish reflex, which may readily be mistaken for the reflex produced by glioma of the retina. The pain is intense until the eye has ruptured and the pus permitted to escape. There is great tenderness upon pressure, and there may also be rapid increase of the body temperature, with the general symptoms of pyrexia. After the rupture of the eyeball and the escape of pus the pain diminishes, the bulb becomes soft, atrophied, and results in phthisis bulbi. The type just described is known as *panophthalmitis.* If the disease occurs as the result of metastasis it produces first some redness and swelling of the ocular conjunctiva, and the globe becomes somewhat harder than normal, and is apparently slightly enlarged. The intraocular tension is also increased. The patient experiences some pain, which, however, as a rule, is not intense. If the globe does not rupture, the inflammatory reaction gradually subsides, the eyeball becomes softer and smaller than normal, in which condition it remains. In a very few instances, usually in young children after cerebro-spinal meningitis, a small amount of vision may remain.

Diagnosis. The external symptoms of purulent choroiditis may resemble somewhat those of orbital cellulitis; in the latter condition, however, the media of the eye remain clear. The condition may be overlooked should it come on as the result of extension of a suppurative process in the cornea or orbit, or as a complication of erysipelas of the lids. A careful examination, including the use of the ophthalmoscope, will usually reveal the nature of the affection.

Prognosis. If the purulent choroiditis involves all the structures of the eye the result is complete blindness,

followed by shrinking of the eyeball. In the few cases in which the affection is confined to the choroid some useful vision may be retained, after a prolonged course of treatment.

Treatment. In the milder cases, in which only a portion of the ocular structures is affected, the treatment is the same as that directed to iritis or iridocyclitis. The application of leeches to the temple, the instillation of atropine, and analgesics for the relief of pain, as well as the constant application of cold compresses, seem to be of benefit in the early stages. In the later stages hot fomentations are better than cold. If the pain is intense it is better to make a free incision through the sclerotic coat and evacuate the pus before the eyeball has ruptured.

There is difference of opinion as to whether an eyeball should be enucleated or eviscerated under the conditions just described, some surgeons refusing to enucleate because cases of meningitis have been known to follow this operation. Others, however, do not believe that there is any more danger of meningitis after enucleation than if the operation is not performed, and do not hesitate to advise it. The advocates of evisceration believe that this is the better operation because the intravaginal lymph spaces of the optic nerve are not opened, and that on this account the micro-organisms are not so liable to gain entrance and affect the meninges of the brain. Should either operation be performed, it is wise to permit free bleeding, and to establish free drainage of the orbital tissues.

Atrophy of the Eyeball is a condition in which the size and shape of the eyeball have become changed because of a contraction following some severe non-suppurative inflammatory process. It is to be distinguished from phthisis bulbi, which is a result of some suppurative inflammation.

Tumors of the Choroid. The variety of tumor most frequently found in the choroid is **sarcoma**, where it usually appears as a pigmented growth, and rarely as a

non-pigmented growth. The patient's attention is ordinarily first directed to the trouble by some defect of the visual acuity. No pain is experienced in the early stage, but as the tumor advances in size a stage is reached in which there is increase of the tension of the eye, accompanied by pain, which is usually referred to the temple. If an ophthalmoscopic examination is made there is found detachment of the retina because this membrane has been pushed forward by the underlying growth. Through the detached retina there may be observed a

FIG. 71.

Sarcoma of the choroid. (Würdemann.)

brownish or a brownish-red mass, over the surface of which bloodvessels may be seen (Fig. 71). If the growth is situated in the anterior portion of the choroid it may be occasionally observed by oblique illumination through a dilated pupil. In the field of vision, a scotoma corresponding to the area occupied by the tumor will be found. If the tumor is situated in the macular region, central vision is naturally much diminished or entirely lost. In the later stage there may be extensive detachment of the retina, the lens may become cataractous, and

an inflammation of the whole uveal tract may follow and be the forerunner of sympathetic trouble in the fellow eye. Sometimes the sclera ruptures and the tumor involves the surrounding tissues, and may even extend backward into the brain. Involvement of other organs of the body by metastasis also occurs. Sarcoma of the choroid is almost always a primary growth, though a few cases of metastatic sarcoma have been recorded.

Prognosis. The prognosis of sarcoma of the choroid is very bad, some authorities stating that death usually occurs within five years after the appearance of the growth if no operation has been performed for its relief in the earlier stage.

Treatment. The eyeball should be enucleated as early as possible before there has been an opportunity for the disease to spread to other tissues. Should the orbital tissues be involved exenteration of the orbit must be performed.

Carcinoma of the Choroid. A few cases of carcinoma of the choroid have been reported, and when it occurs the tumor is usually flat and covers a large area. Vision is affected in proportion to the size of the carcinoma and to its location. The diagnosis must be made, as a rule, from the history of carcinoma in other parts of the body, the failure of visual acuity, and the occurrence of an apparently exaggerated hyperopia which is noted on ophthalmoscopic examination.

The **treatment** consists in the removal of the eyeball if the affection is primary, or if it has advanced so far as to cause marked pain.

Congenital Anomalies. The two congenital conditions which are found in the choroid are *coloboma of the membrane* and a *lack of pigment.*

Coloboma of the Choroid is a congenital condition which results from an arrest in the development of the eye during fœtal life before the choroidal fissure has become entirely closed. The condition is frequently associated with congenital coloboma of the iris (Plate VI.), and at

times there is also present coloboma of the lens and optic nerve. The defect is found to extend downward from the optic disk. Occasionally the defect is double, one coloboma being separated from the other by a band of healthy tissue (Fig. 72). The borders of the coloboma are deeply pigmented, the background being white because of the sclerotic which lies just beneath. A few retinal bloodvessels are sometimes seen passing from the

FIG. 72.

Double coloboma of the choroid.

colobomatous area, indicating that a portion of the retinal layers are present over at least a part of the defect. A scotoma of the visual field is found corresponding to the area occupied by the coloboma. Occasionally a somewhat similar appearance is noted in the macular region and is supposed to be due to intra-uterine inflammation.

Albinism is the name which has been given to that condition in which there is a congenital deficiency of pigment in the choroid and iris. The latter presents a pinkish appearance on account of the reflection of light from its bloodvessels, and from those of the choroid. With the ophthalmoscope the choroidal circulation can be distinctly seen (Fig. 15). The condition is almost always associated with lack of pigment in the hair, and is accompanied by nystagmus, poor vision, and refractive errors. It is frequently found in several members of the same family.

CHAPTER IX.

DISEASES OF THE RETINA.

Anæmia of the Retina. Anæmia of the retina is a symptom of pressure rather than a disease of itself. It is seen when the circulation has been impeded either as the result of compression, or by blocking up of the retinal vessels. It may accompany general anæmia and may be temporarily present in syncope.

Treatment. This consists in the removal of the general anæmia and the employment of such drugs as strychnine and digitalis. If there is spasm of the retinal arteries it may be relieved by inhalations of nitrite of amyl.

Hyperæmia of the Retina is a condition in which there is an abnormal amount of blood throughout the entire retina. If the larger bloodvessels are affected the condition may be readily recognized; if, in addition, the capillaries are affected the surface of the optic nerve becomes redder than normal. If the condition is marked there may even be slight tortuosity of the retinal arteries. Active hyperæmia may be caused by uncorrected, or improperly corrected, refractive error, or by long-continued exposure to bright light. It is characterized by more or less photophobia and discomfort of the eyes in attempting to use them for near work. Passive hyperæmia is caused by any condition which prevents the normal egress of the blood from the retinal vessels.

Treatment. The treatment consists in the removal of the condition which gives rise to the hyperæmia, together with rest of the eyes. Rest may be secured by placing the ciliary muscle under the influence of a cycloplegic. If the hyperæmia should be marked, a few leeches applied to the temple will assist in its reduction.

Retinitis. This is a term which is applied to any inflammatory condition of the retina, and is characterized by a number of symptoms common to all varieties.

Symptoms. The patient may complain of some *change in the visual acuity*, which is more or less marked according to the location of the inflammation and its severity. There may also be some change in the *visual field*, which may be contracted, and in which may be found scotomata. *Hyperæsthesia of the retina* is sometimes found, and manifests itself by discomfort of the eyes in strong light. *Metamorphopsia*, or distortion of vision, which is due to the exudation in the retina, is especially noticed when the macular region is involved. This is observed by the patient in looking at lines, a straight line appearing distorted, one portion seeming displaced as compared with another portion, or the lines may appear to spread apart, or to be crowded together. *The size of the object may also be altered*, appearing either larger or smaller than normal. Objects may not only be distorted in shape, but may appear more or less wavy. There is discomfort in using the eyes, as well as slight photophobia.

Ophthalmoscopic examination will reveal a certain amount of *opacity of the retina*, which may be merely a slight haze, or an area much more dense, and accompanied by swelling. There may also be some streaks of infiltration. If the process has progressed for some time there may be areas in which the exudation can be distinctly observed, appearing as whitish or buff-colored spots. *The vessels are changed in appearance*, the veins being darker than normal, and slightly tortuous. The arteries may also present slight tortuosity on account of the retinal changes. *Hemorrhages* are frequently noted, and may occur either in the superficial or deeper layers. If the hemorrhage is superficial it assumes a "feathery" shape, and is sometimes described under this term; if it appears in the deeper layers, its border is not at all fimbriated. There may be slight or very great *alteration in the papilla*. It may be quite red, its margins indistinct,

and surrounded by considerable swelling of the retinal fibres, with exudate. *Pigment spots* may be found marking the positions of former hemorrhages. *Atrophy of the retina* is sometimes met with as a sequel of retinitis.

Course, Complications, and Prognosis. The course of retinitis may be acute or chronic; that is, it may terminate in a short or a long period of time. The choroid and vitreous sometimes become involved, when numerous vitreous opacities are found. Following retinitis, especially in those cases in which the optic nerve has greatly participated, there may be optic nerve atrophy. The prognosis may be favorable or grave, according to the severity and extent of the inflammatory process, as well as its location.

Causes. Retinitis may occur as a primary disease, but is usually a secondary manifestation of some constitutional affection, such as disease of the kidney, disease of the blood, or syphilis.

Treatment. Absolute rest of the eyes is imperative, and this may be secured by the instillation of a cycloplegic. Protection from light, either by means of smoked glasses, or by confinement in a moderately darkened room, is necessary in those cases in which photophobia is marked. Diaphoresis by means of pilocarpine sweats or Turkish baths, and the internal administration of mercury and iodide of potassium, together with such treatment required to remove the cause, are the therapeutic lines to be followed.

Serous Retinitis (Simple Retinitis, Œdema of the Retina, Diffuse Retinitis). In this variety of retinal inflammation the inflammatory process may be limited to a few spots, or to a large area. One or both eyes may be affected and vision is impaired according to the degree and location of the swelling. The disease may be produced by uncorrected refractive error, by exposure to cold or to extremely bright light. In many cases no cause can be found.

Treatment. The treatment consists in complete rest of the eyes by the instillation of atropine three or four times

a day, protection of the eyes from bright light, the correction of any existing refractive error, and the administration of small doses of iodide of sodium. Any constitutional diathesis must be removed.

Albuminuric Retinitis is a condition of the retina dependent upon a depraved condition of the blood, due in turn to disease of the kidneys and an excessive waste of albuminoids from the blood.

FIG. 73.

Albuminuric retinitis. (De Wecker and Masselon.)

Symptoms. In the beginning there is slight congestion of the disk with haziness of the retina, particularly noticeable at the posterior pole of the eye. In a short time whitish patches appear in the macular region of the retina. These patches are usually arranged in a more or less symmetrical manner, radiating from the fovea centralis and spreading out in the shape of a fan. This condition has sometimes been described as a stellate-shaped

figure (Fig. 73). Whitish spots are also found in the neighborhood of the disk and along the bloodvessels, and are due to exudation. Very frequently numerous hemorrhages are observed and are sometimes seen before the retinal exudation takes place, and when observed are more frequently found in the nerve fibre layer of the retina. The whitish patches observed throughout the fundus are due to the escape of plasma of the blood into the various layers of the retina, and when these patches are diffuse in character the exudate has occurred in the nerve fibre layer, obscuring the bloodvessels and the underlying structures. The clean-cut, well-defined patches are due to the presence of exudate in the deeper layers of the retina. As the disease progresses the exudate becomes more marked, until a stage is reached when the exudate ceases to form, and absorption begins.

Causes. The cause of this condition may be nephritis, either acute or chronic, but it is most frequently seen with that type of Bright's disease in which the chief lesion is the chronic granular kidney. In the acute form of nephritis the retinitis is usually of the *exudative* variety; in chronic nephritis it is usually of the *hemorrhagic* variety. Ordinarily both eyes are affected.

Diagnosis and Prognosis. The diagnosis of albuminuric retinitis is made by ophthalmoscopic examination, when that condition of the retina which is practically pathognomonic of the disease is found. This condition has been described under the symptoms. A somewhat similar condition is met with in certain extremely rare instances of brain disease (Fig. 74). In every case in which hemorrhage or exudate is discovered in the retina the urine should be carefully examined. *The prognosis* of albuminuric retinitis is always very grave, but is better in that type which occurs during pregnancy than in any other. In the latter condition the prognosis is good or bad according to the time of appearance of the retinitis, and the duration of gestation. When the period of gestation has ended the inflammatory condition may subside,

with the restoration of good vision, provided the condition has not been present for a long time. Because of this, it has been recommended in some cases to induce premature labor.

In those cases occurring independent of pregnancy or scarlet fever the prognosis is bad, both as regards vision and life. Vision is usually markedly impaired because of the involvement of the macular region, and the larger

FIG. 74.

Optic neuritis and star-shaped macular figure simulating appearances seen in albuminuric retinitis. Kidneys normal. (de Schweinitz.)

proportion of these cases die within two years after the appearance of the retinal disease. Occasionally life may be prolonged beyond this period, but it is exceedingly rare.

Treatment. The eye must be given rest, as in any other form of retinitis. The best vision possible should be obtained by use of proper glasses. In addition to these, the treatment must be directed to that of the gen-

eral condition of the patient, and the treatment of the nephritic disease giving rise to the retinal lesion..

Diabetic Retinitis. This is a variety of retinitis which is found in patients suffering from diabetes It is most frequently found in those who are affected with diabetes mellitus, but in rare instances has been observed in those affected with diabetes insipidus. It occurs very late in the disease.

Symptoms. The symptoms are somewhat similar to those of albuminuric retinitis. Central vision is somewhat impaired, there is contraction of the visual fields, and the plaques which are observed throughout the fundus are more yellowish in color than those occurring in albuminuric retinitis. The hemorrhages are also larger in size and greater in number, than are usually found in the former disease. The peculiar radiating figure which is seen in the macular region in albuminuric retinitis is not observed in this affection.

Diagnosis and Prognosis. The diagnosis is made by the ophthalmoscopic examination and the examination of the urine. The prognosis is grave but not so quickly fatal to life as in albuminuric retinitis. Central vision may be very greatly impaired or entirely destroyed by involvement of the macular region.

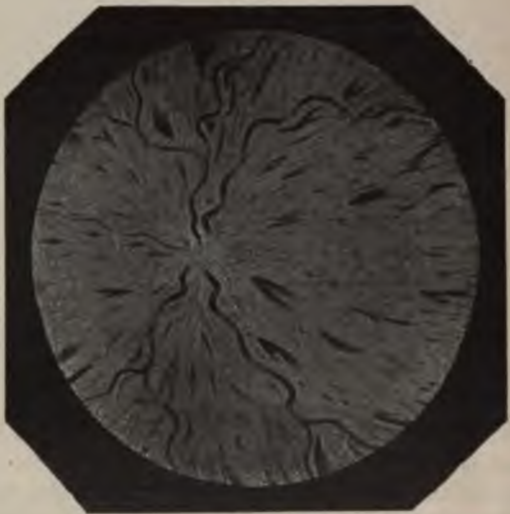
Treatment. The treatment consists in the management of the diabetic conditon, as local treatment is of very little use. The eyes must be rested, as in any other variety of retinal disease.

Syphilitic Retinitis. This disease is usually associated with, and is very frequently secondary to, disease of the choroid, and is found in both the acquired and the congenital varieties of syphilis. There is more or less exudation, as well as a number of hemorrhages, profuse in character, the latter sometimes passing into the vitreous. The condition is almost always accompanied by a thickening of the walls of the vessels, in reality a syphilitic periarteritis and endarteritis. The disturbance to vision is very marked, especially if the region of the macula is

involved. If the choroid is involved the condition is sometimes known as *chorio-retinitis*. As the condition progresses toward recovery the exudate and the hemorrhages gradually become absorbed, leaving the arteries reduced in size, atrophic patches in the choroid, and streaks of connective tissue in various parts of the vitreous.

Treatment. The treatment should consist of the early and continuous administration of mercury and iodide of potassium. The eyes should be rested by maintaining mydriasis, and strong light should be avoided by the use of smoked glasses. Sometimes rest in bed and restricted diet are necessary if large hemorrhages are found.

FIG. 75.



Hemorrhagic retinitis. (Jaeger.)

Hemorrhagic Retinitis (Apoplexy of the Retina). This variety of retinitis is, in the beginning, usually confined to one eye. The vision is more or less impaired, according to the location of the hemorrhages. The patient may have observed colored vision, and the ophthal-

PLATE IX.

Retinal hemorrhages, arterio-sclerosis, venous obliteration.

moscopic examination reveals numerous feathery-shaped hemorrhages, which are usually confined to the fibre layer of the retina. There may be slight inflammation of the optic nerve, together with œdema of the surrounding retina. The retinal veins may be distended and tortuous, and if there have been previous hemorrhages numerous whitish plaques will be observed marking their positions. This form of retinitis is usually dependent upon the condition of the bloodvessels and is most frequently found in elderly people.

A variety of retinal hemorrhage, without much retinal inflammation, is found in young people who are affected with arterial or cardiac disease, the walls of the arteries usually being much thickened. (See Plate IX.) Where the arteries cross the veins it can be observed that they are much thicker and more opaque than normal, and that indentations are made in the veins, impeding the egress of the blood current. Because of this stasis the vessels rupture, and numerous hemorrhages are observed.

Treatment. Atropine should be instilled, the eye should be protected from strong light by smoked glasses or a bandage, and if active bleeding is going on the patient should rest in bed for a few days, taking large doses of the fluid extract of ergot. As hypodermic injections of gelatine have proved of service in hemorrhage in other organs of the body they might be tried in this condition if the bleeding continued. Later iodide of sodium and pilocarpine sweats are of use in clearing up the hemorrhagic areas. The correction of any abnormal condition of the heart should be attended to. It has been pointed out by Mr. Gunn that when retinal hemorrhages of this character are observed there is probability of death from cerebral hemorrhage within a comparatively short time.

Leukæmic Retinitis is a variety of retinal inflammation characterized by general swelling and opacity of the retina, sometimes involving the optic disk, which is found in profound leukæmia and pernicious anæmia. The

fundus is a very pale red or yellow in color, the retinal veins are markedly enlarged, and in the late stages of the disease there are numerous feathery-shaped hemorrhages. If the affection has been present for some time there may be patches of dense exudate. Both eyes are usually affected.

Treatment. The treatment is that of retinitis in general, in addition to the treatment of that condition of the blood which gives rise to the disease.

Circinate Retinitis is a name given by Fuchs to a condition which is characterized by a circular arrangement around the disk, or macular region, of whitish patches and radiating lines which are apparently situated in the deeper layers of the retina. Occasionally these spots are arranged in the shape of an ellipse, one end of which is in the neighborhood of the optic disk, the other extending some distance beyond the macular region. Sometimes hemorrhages are observed, and vision is much reduced.

Striate Retinitis is a condition which is characterized by a number of light stripes which extend from the periphery of the fundus toward the disk, and which are sometimes bordered by lines of pigment. The origin of the affection is not positively determined, but it is probable that the condition is somewhat analogous to angioid streaks of the retina. This analogy, however, is denied by some authors.

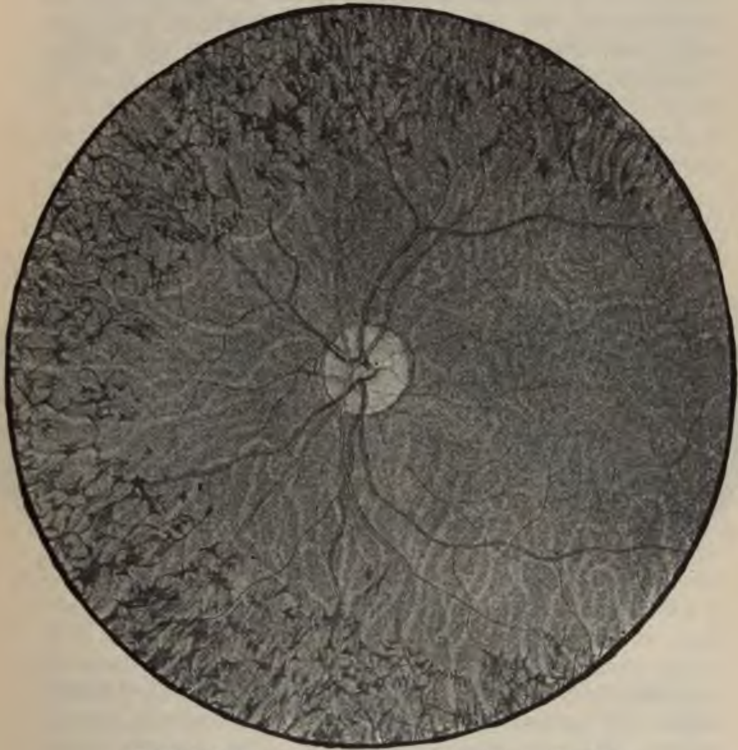
Central Punctate Retinitis is another variety of retinitis in which there are a number of spots or lines scattered throughout the fundus, but especially marked in the macular region. The optic nerve is somewhat gray. There may be a scotoma without any contraction of the periphery of the visual field. Hemorrhages into the vitreous sometimes occur.

Proliferating Retinitis is characterized by the formation of dense masses of connective tissue which extend from the retina into the vitreous, and are usually found after an attack of retinitis in which there has been ex-

cessive hemorrhage. It is observed as a result of retiniti rather than as a pathological process of itself.

Retinitis Pigmentosa (Pigmentary Degeneration of the Retina). This affection is, as a rule, congenital, the

FIG. 76.

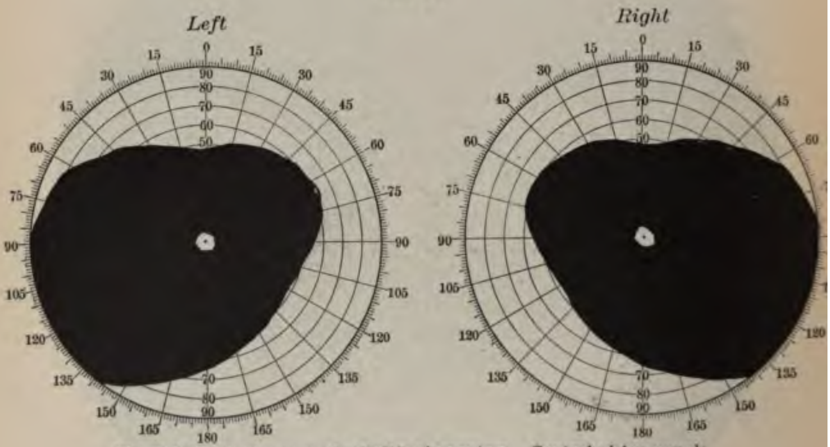


Typical pigmentary degeneration of the retina. (Jaeger.)

earliest symptom noted being night-blindness. Ophthalmoscopically there are found numerous small stellate pigment patches which are first observed in the extreme periphery of the retina. It is a degenerative rather than an inflammatory process, and affects the choroid as well

as the retina. It is a disease of long duration, the first symptoms being noted in early life, but gradually increases in intensity and ultimately produces almost complete blindness. The pigmentation is stellate-shaped, looking not unlike bone corpuscles, and consists in hypertrophy of the retinal pigment which advances into the substance of the retina in the form of minute prolongations and reaches and follows the course of the smaller retinal vessels. The retinal vessels are much reduced in

FIG. 77.



Visual fields from a case of retinitis pigmentosa. Central vision equals 5/40 in each eye.

size, the optic disk becomes pale in appearance, the visual fields are contracted concentrically until finally only a minute field remains (Fig. 77). The patients have great difficulty in seeing at night, the night-blindness being due to the small area of retina functionating and the sluggish condition of the remaining approximately normal portion. In exceedingly rare instances the disease begins in the macular region, when it is termed *retinitis pigmentosa centralis.*

Causes. In a certain number of cases of retinitis pigmentosa there has been consanguinity of parents or heredity. Inherited syphilis is undoubtedly the cause in other cases. The affection sometimes accompanies deaf-mutism.

Treatment. Unfortunately, treatment is of little avail in this affection. Occasionally cases are met with in which the progress of the disease seems checked for a time, but this is also observed at times independent of any course of treatment. The health of the patient should be put in the best possible condition and maintained. Hypodermics of strychnine and the local use of galvanism have been advocated as remedies to be employed.

Embolism and Thrombus of the Central Retinal Artery. If an embolus lodges in the central artery of the retina it produces complete and instantaneous blindness of the eye; if it lodges in one of its branches, however, it produces blindness in a portion only of the visual field. Vision is lost suddenly and is not accompanied by pain.

With the ophthalmoscope the fundus appears much paler than usual, the arteries are small, containing very little blood, and the latter may appear to be broken instead of a continuous stream. The fovea centralis appears as a bright red spot, sometimes known as the *cherry-red spot*, which is due to the appearance of the choroid through the thinnest part of the retina. In a few hours the retina may become grayish-white and somewhat œdematous, the optic disk becoming more pale. Should only a branch of the retinal artery be blocked the symptoms will be confined to that portion of the retina which the branch supplies. A *thrombus* may sometimes be diagnosed because of the longer time required for the symptoms to appear, as well as a history of previous attacks of transient blindness.

Causes. The most frequent cause of embolism of the central artery of the retina is some disease of the cardiac valves. It is sometimes found, however, to occur in

Bright's disease, in arterial sclerosis, etc. It is usually confined to one eye.

Prognosis. The prognosis is exceedingly unfavorable so far as vision is concerned.

Treatment. The treatment, as a rule, proves of little avail. Iridectomy, sclerotomy, and paracentesis of the anterior chamber have been employed, with the idea of restoring the circulation or reducing intraocular tension. Massage of the eyeball has also been recommended. Inhalations of nitrite of amyl may be tried.

Thrombosis of the Central Vein is complete or partial, and is usually accompanied by sudden blindness. The retinal veins become enormously dilated and tortuous, their walls giving way in various places and producing many large and small hemorrhages. The arteries are diminished in size, but can be made to pulsate by slight pressure upon the eyeball. The disease usually results in atrophy of the optic nerve and retina, and is found in people who have atheromatous arteries, but in some cases no cause can be found.

Detachment of the Retina (Amotio Retinæ). This condition consists of a separation of the retina from the choroid by means of a serous fluid or new-growth.

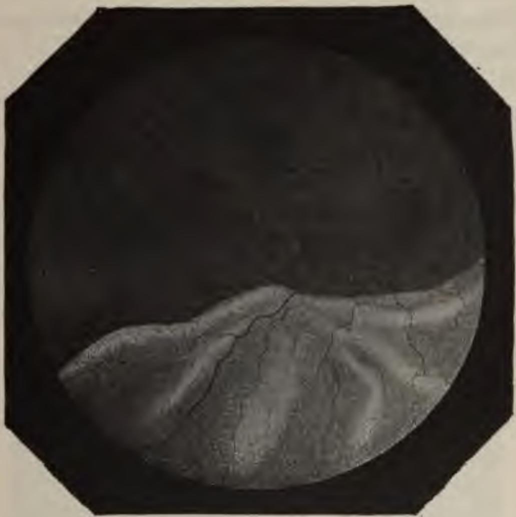
Symptoms. The symptoms consist of a complete or partial loss of visual acuity, the amount depending upon the extent and location of the detachment. As a rule, the condition comes on suddenly. At first only a portion of the retina is detached, but ultimately the whole retina may be separated from the choroid with the exception of the attachment around the optic disk and at the ora serrata in front. There is loss of that portion of the visual field corresponding to the detached portion of the retina. Either one or both eyes may be affected.

The ophthalmoscope shows the detached portion of the retina waving in the vitreous (Fig. 78). Its appearance is opaque, and upon it branches of the retinal vessels can usually be observed. In a very slight detachment the opacity is not noticed, and the condition may be

detected only by the displacement of the retinal vessels. In a detachment just beginning there may be observed a peculiar mottled appearance.

Causes. The causes of retinal detachment may be due to traumatism or disease. It is found more frequently in men than in women, and is sometimes observed in high myopia.

FIG. 78.



Detachment of the retina. (Jaeger.)

Diagnosis. The diagnosis is determined by the use of the ophthalmoscope and the appearance of the symptoms just described. The *prognosis* is bad, vision, as a rule, being ultimately lost.

Treatment. The treatment consists of rest in bed, together with absolute rest of the eye. The latter may be obtained by the use of a mydriatic and a light bandage. The internal administration of the iodides and the salicylates have proved of benefit in some cases, as have also pilocarpine sweats. The withdrawal of the subretinal

fluid by means of a scleral puncture (posterior sclerotomy) has been employed with good temporary results in some cases, but unfortunately at a later period the retina becomes re-detached. Subconjunctival injections of solutions of sodium chloride have recently been strongly advocated in this condition.

Glioma of the Retina is the form of tumor most frequently met with in this portion of the eye. It is a variety of sarcoma which may spring from any portion of the retinal tissue, and occurs in early childhood. The growth is at first slow, but in the later stages becomes very rapid. Sometimes the reflex which is obtained from the growth,

FIG. 79.

Glioma of the retina. (Leber.)

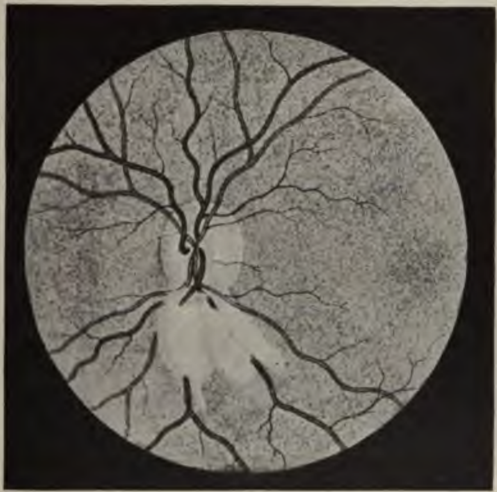
by throwing light into the pupil, causes it to resemble somewhat the condition of purulent choroiditis. When it has attained considerable size the eyeball becomes hard, red, and tender to the touch. It extends through the optic nerve to the brain if unchecked.

Treatment. The treatment consists in the earliest possible removal of the globe of the eye, the optic nerve being divided as deep in the orbit as possible. If the orbital tissues are involved exenteration of the orbit must be performed.

Congenital Defects. The principal congenital defect of the retina is the condition known as *opaque nerve fibres.*

These are fibres which pass from the optic nerve to the retina still retaining the medullary substance present in the nerve fibres in other parts of the body, especially those which go to make up the large nerve trunks. These fibres are spread out over the retina most frequently in the neighborhood of the optic disk, but occasionally in the periphery, and present white patches which obscure all details of that portion of the fundus which they occupy (Fig. 80). Their condition does not change.

FIG. 80.



Opaque nerve fibres. (De Wecker and Masselon.)

Sometimes the retinal vessels vary in distribution and appearance. Normally they are not tortuous, but at times there is a *congenital tortuosity* which is difficult to distinguish from a similar condition observed in neuroretinitis.

As a congenital condition there may also be observed *pigment spots* between the bloodvessels, or occasionally small *white spots* in the neighborhood of the macula.

CHAPTER X.

DISEASES OF THE OPTIC NERVE.

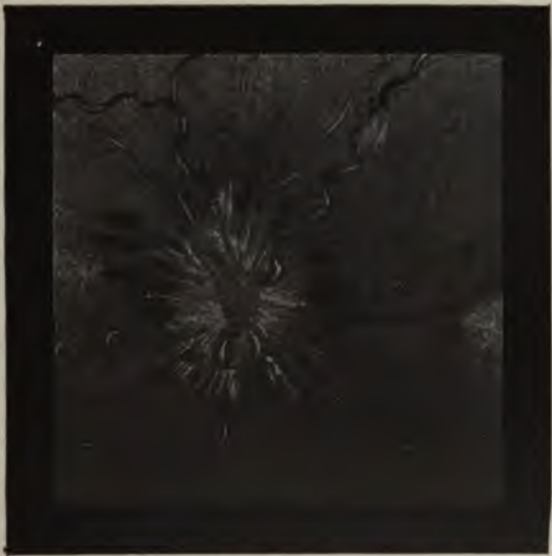
It is usual to describe two varieties of optic nerve inflammation. The first, or that condition in which ophthalmoscopic examination reveals an inflammatory condition of the nerve head, is sometimes called *papillitis*, or *intraocular optic neuritis*. The second, or that condition in which vision is markedly disturbed and in which the ophthalmoscope reveals but very slight changes in the optic disk, or none at all, is termed *retrobulbar neuritis*, or *orbital optic neuritis*.

Intraocular Optic Neuritis (Papillitis, Choked Disk). Inflammations of the optic nerve are of the greatest importance not only as regards the loss of vision, which sometimes accompanies them, but because their appearance is of the greatest assistance in the diagnosis of certain affections. The symptoms vary greatly according to the intensity of the swelling.

Symptoms. An ophthalmoscopic examination will reveal swelling of the intraocular end of the optic nerve. This may be so great that the edges have become much blurred or entirely obliterated, the position of the nerve being known principally by the convergence of the bloodvessels. In addition there is increased vascularity and certain changes in the vessels. The arteries become smaller than normal, and are partially hidden by the swelling. The veins are larger than normal, more or less tortuous according to the intensity of the inflammation, and are darker than usual. This tortuosity may be so great in some instances as to present the so-called "corkscrew" appearance. In some cases there are

hemorrhages upon the surface of the disk and in its immediate neighborhood. If they occur in the fibre layer of the retina they are feather-shaped in appearance, but if they occur in the deeper layers their edges are cleaner cut. In severe cases of optic neuritis there may be small patches of exudate in other portions of the retina as well

FIG. 81.



Acute optic neuritis. Note disk much swollen: estimated at + 7 D. Edge indistinct; vessels obscured at edge; large number of hemorrhages around the disk, patches of œdema in the retina, veins very tortuous. (Spicer.)

as in the immediate neighborhood of the optic disk itself. Portions of the vessels may be entirely covered with the exudate so that they can scarcely be distinguished. The degree of swelling is usually measured by the ophthalmoscope in dioptres. Ordinarily 3 dioptres of refraction indicate about 1 millimetre of swelling. To those cases in which the swelling is very excessive, and which were

supposed to be due to the great compression preventing the egress of blood from the eye, the term *choked disk* has sometimes been given; to those in which there is considerable involvement of the retina, in addition to the optic nerve, the term *neuroretinitis* has been given (Fig. 82). *Descending neuritis* is a term which has some-

FIG. 82.

Neuroretinitis. (De Wecker and Masselon.)

times been used to describe a moderate swelling of the nerve head with very little distention or tortuosity of the veins, and the appearance of exudate which is not limited to the disk but passes into the surrounding retina. It is better that all of these varieties, however, should be described under one heading. Central vision is sometimes markedly reduced and at other times scarcely affected. Those cases in which the macular bundle of nerve fibres is affected present the greatest reduction of vision. The visual field may be contracted concentrically

or remain unaltered. The normal blind spot may be increased in size, or abnormal scotomata may be found. The changes in the visual field are infrequently limited to abnormal color perception.

Diagnosis. The diagnosis of papillitis can only be made by an ophthalmoscopic examination. Occasionally, in

FIG. 83.

Swollen disk in a case of chronic meningitis. (Liebreich.)

conditions of high hyperopia, there is a slight reddening of the surface of the disk, together with some blurring of the edges (*spurious optic neuritis*) which it is sometimes difficult to differentiate from a low-grade optic neuritis, but a careful study of the case as regards refraction, the visual field, and its course will usually determine the true condition.

Course. The course of papillitis is usually slow. In the acute cases accompanying cerebral conditions there may result partial or complete atrophy of the optic nerve. Very rarely a second attack of neuritis may occur in a previously affected nerve.

Causes. The most frequent cause of severe optic neuritis is some pathological condition of the brain and its membranes. It is stated that it occurs at some time or other in 90 per cent. of all cases of brain tumor. It is also produced by cerebral abscess, thrombosis of the lateral and cavernous sinuses and meningitis. Cerebral hemorrhage very rarely gives rise to optic neuritis. It may also be occasioned, however, by acute febrile diseases, syphilis, anæmia, menstrual disturbances, exposure to cold, and injuries, as well as by orbital disease.

There have been advanced many theories as to the *mechanism of optic neuritis.* It may be produced by an extension of the inflammatory process from the surrounding parts, or by certain poisons. In connection with its appearance in cerebral tumors two principal theories have been advanced. The first is that the enormous swelling and inflammatory condition is brought about through increased intracranial pressure extending to the optic nerve, the vessels of the nerve being compressed so that the passage of blood from the eye is impeded. The second, or inflammatory theory, is that the fluid in the nerve sheath is irritating and produces inflammation, this being brought about by infection from the intracranial disease. It is likely that both of these conditions have something to do with most cases.

Treatment. The important factor in the management of these cases is to remove the cause if possible. The pressure upon the optic nerve fibres should be removed as rapidly as possible in order to prevent a subsequent optic-nerve atrophy. If there is an intracranial tumor or abscess, an operation either with or without removal usually helps the optic neuritis because of the relief of intracranial pressure. In syphilitic cases the rapid ad-

ministration of antisyphilitic remedies is called for. In non-syphilitic cases large and rapidly increasing doses of iodide of potassium assist in the removal of the exudate and in the subsidence of the swelling. Iron, arsenic, and the salicylates, according to the condition present, will be found of benefit in some cases. The eyes should not be used for close work, and in the later stages, when the exudate has been mostly absorbed and the swelling has largely subsided, full doses of strychnine, administered by mouth or by hypodermics in the temple, are of the greatest benefit. Galvanism has also been recommended, but does not seem to be of much use, as it is doubtful whether any of the current reaches the nerve fibres.

Orbital Optic Neuritis (Retrobulbar Neuritis, Central Amblyopia). This variety of optic neuritis has its intensity of inflammation located behind the eyeball in the orbital part of the optic nerve. It is usual to describe two varieties, the *acute* and *chronic*.

Acute Retrobulbar Neuritis. There is rapid loss of central vision in one eye, accompanied by some pain and discomfort upon moving the eye, together with deep-seated tenderness in the orbital cavity. Even when central vision is comparatively good there is a complaint of haziness or fogginess in front of the eyes. An ophthalmoscopic examination at first reveals nothing abnormal, but later there may appear a slight haziness of the disk, which becomes paler than usual. After some weeks the undoubted signs of optic nerve atrophy may appear.

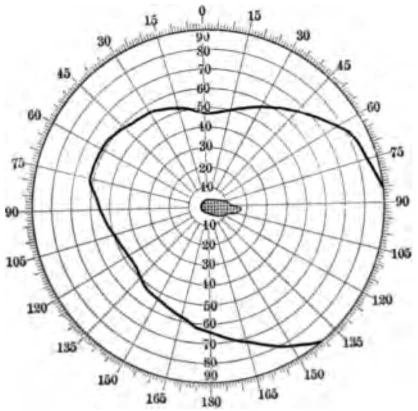
The affection runs an acute course, and may end either in complete blindness or in recovery of all or a part of normal vision. It may be caused by orbital disease, menstrual disorders, rheumatism, gout, and malaria. It may also be produced by injury.

Treatment. The treatment consists in the removal of the cause. Abstraction of blood by the application of leeches and the internal administration of iodide of potassium, either with or without profuse diaphoresis by means of hypodermic injections of pilocarpine, are of benefit.

In the later stages strychnine is to be employed for its effect upon the optic nerve fibres.

Chronic Retrobulbar Neuritis (Toxic Amblyopia, Tobacco-alcohol Amblyopia). This variety of retrobulbar neuritis is similar to the acute except that it pursues a much more chronic course, requiring a longer time for the symptoms to become manifest. The patient first notices a diminution, or "fogginess," of central vision which glasses do not improve. This reduction of vision may be only slight or very great. An ophthalmoscopic examination may

FIG. 84.



Central relative scotoma from a case of tobacco amblyopia.

reveal a normal appearance of the nerve head, or it may be quite pale in the lower outer quadrant. The periphery of the visual fields is unchanged, but in the centre of each there is found a scotoma, either relative or absolute, according to the stage of the disease. Green is the first color to disappear in this scotomatous area, and is followed by red and blue, and last by the inability to recognize form. The scotomata are usually of an oval shape, and extend from the region of the fixation point to the point corresponding to the optic nerve entrance (Fig. 84).

Causes. The most frequent causes of this affection are the excessive use of tobacco and alcohol. A great many drugs will also produce the same symptoms, viz., lead, iodoform, nitrobenzol, bisulphide of carbon, cannabis indica, and several others. Toxic amblyopia from tobacco or alcohol usually occurs after the thirty-fifth year.

The lesion produced by this form of amblyopia is an inflammation of the papillo-macular bundle of fibres of the optic nerve which may result finally in atrophy; and it is for this reason that in the late stages of the disease the lower outer quadrant of the optic nerve, or that portion occupied by the papillo-macular bundle appears pale. It is now believed that in certain varieties the disease primarily affects the ganglion cells of the retina, and secondarily involves the papillo-macular bundle of nerve fibres.

Prognosis. The prognosis depends upon the stage of the affection when the patient comes under observation, and whether or not the cause can be entirely removed.

Treatment. The most important feature in the treatment of chronic retrobulbar neuritis is to remove the cause as early as possible. If it is due to excessive use of tobacco or alcohol, these must be absolutely prohibited. The internal administration of the iodides, and Turkish baths or pilocarpine sweats, will assist in the removal of the toxic substance from the system. For its effect upon the diseased nerve fibres, strychnine should be given in full doses. Slight temporary improvement has been observed to follow inhalations of nitrite of amyl.

Atrophy of the Optic Nerve. This is a general term which is applied to the optic nerve when its fibres have become more or less degenerated from various causes. There are many varieties of optic nerve atrophy, but for the present purpose it will suffice to describe only two, viz., *primary atrophy* and *secondary atrophy*.

Symptoms. The principal symptom observed by the patient is gradual impairment of vision. This is true for both distant and near vision. If an ophthalmoscopic

examination is made certain changes in the optic disk will be observed. The color of the disk may be a lustreless white, or gray, or greenish. It has lost its translucency and appears opaque. The physiological cup, usually noted in the neighborhood of the centre of the disk, may have changed in character, or have become obliterated. The lamina cribrosa may or may not be more distinctly observed than in the normal nerve. In some cases the whole optic nerve appears to be cupped. The vessels may be normal, but, as a rule, the arteries are diminished in size.

FIG. 85.

Simple atrophy of disk. Stippling of lamina cribrosa exposed. (De Wecker.)

FIG. 86.

Atrophy of disk from spinal disease. Lamina cribrosa concealed. Vessels normal. (De Wecker.)

If the field of vision is taken many curious changes are observed. There may be concentric contraction of the field for form and colors, or the form field may be normal and the color fields markedly contracted. Irregular contractions are sometimes met with as well as the concentric variety. Many varieties of scotomata are also seen.

Primary Atrophy is an atrophy occurring without any apparent pre-existing cause, and is sometimes called *progressive atrophy*. It is a form of atrophy which is found in connection with tabes dorsalis, but is also occasionally observed in disseminated sclerosis, or as a result of poison from syphilis, etc. A number of cases of *congenital atrophy* of this character have been reported, many

of them being hereditary. In primary atrophy the nerve head usually appears chalky white, the edges being clean-cut.

Secondary Atrophy is that variety of optic nerve atrophy which appears as a result of some pre-existing disease, as optic neuritis, retinal disease, or traumatism. That variety following optic neuritis is sometimes known as *consecutive*, or *postneuritc atrophy.* In this variety the physiological cup has been filled by the exudate occurring

FIG. 87.

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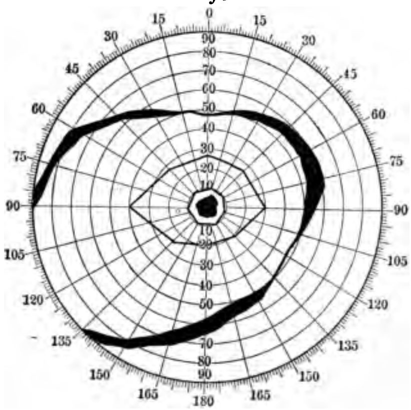


Field of vision from a case of postneuritic optic atrophy. Very little contraction for form, but marked contraction for red and green, with an absolute central scotoma. From without inward the fields are white, red, and green.

in the inflammatory stage, and the edges of the disk are not clean-cut, as in primary atrophy. Following the course of the vessels whitish lines are observed which are indicative of the previous inflammatory process.

The condition of the nerve in primary atrophy is brought about by a sclerosis and shrinking of the nerve fibres. The condition of the nerve in secondary atrophy is usually brought about by prolonged compression of the nerve fibres.

Prognosis. The prognosis in optic nerve atrophy is exceedingly grave. In a large number of cases the disease goes on until complete blindness ensues. The best that can be hoped for, in the milder cases, is to check the process and retain what vision the patient has. In some cases following the toxic amblyopias or acute disease, marked improvement or complete restoration of vision may be hoped for. The retardation or progression of the affection will depend largely upon the condition of the visual field. If the latter is becoming gradually smaller the prognosis is very bad; if it remains unchanged, however, the hope of retaining some vision may be entertained.

Treatment. The general health of the patient must be improved as much as possible, together with the removal of the cause of the atrophy, if this can be determined. The internal administration of full doses of strychnine, or hypodermic injections of the same drug into the temple, is of benefit. Nitroglycerine internally and the inhalation of nitrite of amyl daily are advocated for their effect upon the vascular supply of the nerve. The employment of galvanism seems to be of doubtful advantage.

Hemorrhage into the Optic Nerve Sheath is occasionally met with and is characterized by a sudden loss of the visual acuity. Upon ophthalmoscopic examination there will be noted sometimes a small crescent-shaped hemorrhage partly encircling the disk at its margin. In other cases the ophthalmoscope will reveal no abnormal condition.

Treatment. The treatment consists in the rest of the eye, the administration of the iodides and pilocarpine sweats for the absorption of the clot.

Hyaline Bodies in the Papilla. In this condition there are a number of small rounded masses, sometimes described as colloid, found in the optic nerve head. They are exceedingly rare and present a yellowish or bluish appearance when examined with the ophthalmoscope. They are sometimes found in eyes which have been

damaged by disease, but have also been observed in eyes otherwise normal, vision not being interfered with.

Tumors of the Optic Nerve. These are exceedingly rare, but many varieties have been reported, including *fibroma*, *myxoma*, *sarcoma*, *glioma*, *endothelioma*, etc. When they become sufficiently large they produce exophthalmos. Movements of the eyeball are unaffected, but vision is generally interfered with in the early stage. An ophthalmoscopic examination usually shows an optic neuritis, which is followed later by atrophy of the nerve.

Treatment. The treatment consists in the removal of the growth as soon as it is recognized. If it is possible an attempt should be made to remove it without sacrificing the eyeball, but if this cannot be done, enucleation must be performed.

Congenital Anomalies. **Coloboma of the Sheath of the Optic Nerve** is occasionally met with and is characterized by an apparent enlargement of the surface of the disk with slight excavation below. There may be some pigment on its edge. The excavation is usually deep, the principal bloodvessels curving perpendicularly over the edge. It depends upon imperfect closure of the fœtal fissure.

Connective Tissue Bands are sometimes seen upon the surface of the disk and may be due to prolongation of the lamina cribrosa. They are sometimes transparent and sometimes opaque, and may also be due to the remains of the hyaloid artery.

Opaque Nerve Fibres have been described under congenital defects of the retina (Fig. 80).

CHAPTER XI.

AMBLYOPIA.

Amblyopia is a term which is usually employed to describe those cases in which the vision remains subnormal without ophthalmoscopic change. It does not refer to those conditions in which the vision is reduced on account of a refractive error, and which become normal after its correction.

Amaurosis is a term which is usually employed to describe that condition in which the eye is absolutely blind without ophthalmoscopic change. Both terms have been employed rarely in those cases with reduced vision due to inflammatory conditions.

Congenital Amblyopia. Congenital amblyopia is that condition of the eye in which there is a congenital deficiency of vision. It is, as a rule, confined to one eye, though bóth may be affected, and in many cases there exists a squint in the amblyopic eye. In some instances the condition is not discovered until an examination is made by an ophthalmic surgeon. The condition is frequently associated with high degrees of hyperopia, myopia, and astigmatism. In this class of cases clear images have not been focused upon the retina on account of the high refractive errors, and this want of use has probably produced the amblyopia. The proper correction of the refraction does not immediately increase the vision to normal, but after the use of glasses for a considerable period of time some increase in the visual acuity may be noted.

Any condition in early life which interferes with the perfect formation of images upon the retina, such as congenital cataracts, may produce the so-called *amblyopia*

ex anopsia or *amblyopia from non-use*. This term was formerly applied to all cases of squint in which the vision was subnormal, but that it does not always hold good is proved by the fact that in some cases of squint the vision is normal in each eye.

There is very little tendency for congenital amblyopia to change for the better or worse; but a number of instances have been recorded in which after injury destroying the vision of a normal eye, the vision of its fellow, or amblyopic, eye has been materially improved, evidently because of the necessity for its use.

It is always worth while in cases of congenital amblyopia, unilateral in character, to cover the good eye for several hours a day, thus throwing the necessity for work upon the amblyopic eye. By this means the vision can sometimes be improved.

Congenital Amblyopia for Colors is a condition met with most frequently in males in whom there is an inability to distinguish between the different colors. The condition is frequently hereditary, and is incurable. The eyes present no abnormal appearance, and, indeed, some individuals do not discover that they are color-blind until very late in life. The cause and pathology are unknown. As a rule, the individuals who have congenital color amblyopia have not complete loss of color sense, but loss of ability to distinguish between some of the fundamental colors. The tests for color blindness have been given on page 31.

Reflex Amblyopia is occasionally met with, the most frequent cause probably being irritation of a nerve by some defect of a tooth. The condition disappears upon the removal of the exciting cause.

Uræmic Amblyopia is observed in cases of nephritic disease due to scarlet fever or pregnancy, but may also occur in patients affected with albuminuric retinitis. The amblyopia presents itself quite suddenly, the patient frequently waking to find himself blind after having retired the night before with good vision. Both eyes

are affected, and it is usually associated with other symptoms of uræmia. The pupils are usually dilated, but react to light. The blindness lasts for two or three days, when the sight may be entirely regained. A similar condition is sometimes met with in diabetes.

Amblyopia from Loss of Blood. Sometimes following excessive hemorrhage, loss of vision is observed. It is more frequently seen when the hemorrhage is spontaneous than after a hemorrhage produced by traumatism. The loss of vision may be only temporary, or it may be permanent, and followed by atrophy of the optic nerve. With the ophthalmoscope the optic disk is usually seen to be more or less pale with contraction of the arteries. There may also be present some involvement of the nerve, together with retinal hemorrhages.

Treatment. The treatment consists in complete rest in bed, the use of iron, arsenic, and strychnine, as well as transfusion.

Amblyopia from Drugs. Some substances (tobacco, alcohol, etc.) produce amblyopia by means of an *orbital optic neuritis*, and the condition has been described under this heading. An amblyopia may arise, however, from the toxic influence of many other substances, such as nitrate of silver, mercury, nitrobenzol, cannabis indica, iodoform, chloral, lead, salicylic acid, and quinine. In *quinine amblyopia* the symptoms may appear after a moderate dose, although they are more frequently met with after excessive quantities have been taken. The *symptoms* of quinine-blindness are total loss of vision, extreme paleness of the optic disks, diminution of the retinal bloodvessels in number and calibre, and contraction of the field of vision.

The *result* of an attack of quinine blindness may be partial or complete recovery of central vision.

As demonstrated by de Schweinitz in his experiments upon dogs, the toxic influence of quinine is to lessen, through spasm of the vessels, the blood supply of the retina and optic nerve, and later permanent optic nerve

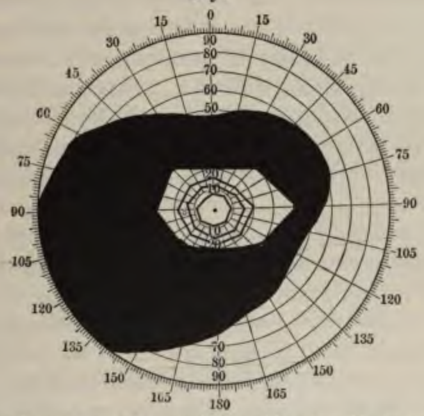
atrophy may follow. It has been recently shown by Ward Holden that the effect of the diminished blood supply is a degeneration of the ganglion cells and nerve fibres of the retina, which is followed by an ascending degeneration of the optic nerve.

Treatment. The treatment consists in inhalations of nitrite of amyl and the internal administration of strychnine and digitalis. The use of the drug should, of course, be discontinued.

Hysterical Amblyopia is a marked reduction of the visual acuity, which is usually associated with some of

FIG. 88.

Left



Field of vision from a case of hysterical amblyopia. Marked concentric contraction, with complete reversal of the red and blue fields. From without inward the fields are for white, red, blue, and green.

the other signs of hysteria. The patient may complain of photophobia and of flashes of light. There may be hemianæsthesia of the face or limbs, as well as of the conjunctiva and cornea. A spasm, or paresis, of accommodation is also occasionally observed. Vision may be entirely abolished, or only partially lost, and the affection is usually unilateral. It is most frequently met with in young

girls and women. In rare instances *complete amaurosis* is observed.

The fields of vision are contracted concentrically, and in many instances there will be found a complete or partial reversion of the color fields. The condition may last for a long time, but the prognosis for recovery is, as a rule, good.

Treatment. The treatment consists of the use of such means as will improve the nutrition of the patient, such as general tonics, rest, massage, and electricity. In some cases the condition is relieved by suggestion.

Simulated Amblyopia (Malingering). A number of individuals are met with from time to time who, in order to escape from some duty such as military service, or in the attempt to secure compensation for some alleged injury, pretend to be blind in one eye. In some of these cases it is exceedingly difficult, and especially so in the individual who claims to be blind in both eyes, to detect the falsity of the statements made. There are a number of tests, however, which are employed to detect this condition:

1. If a prism of 6 or 8 degrees' strength be placed with its base down in front of the eye which the patient claims to be good, and diplopia is observed, with one image above the other, when looking at a lighted candle 5 or 6 metres in front of him, there is vision in both eyes.

2. If the accommodation is paralyzed by means of atropine or other cycloplegic in the eye which is claimed to be good, and the patient with both eyes open can read small print, the other eye is not blind. It may, however, be very myopic, which can be determined by an ophthalmoscopic examination.

3. This test, devised by Harlan, is extremely useful. A trial frame is placed in front of the patient's face as if he were being tested for glasses. Simultaneously there is placed in front of the supposed good eye a + S. 16 D. lens, and in front of the eye which is claimed to be blind a plane glass, or a — S. 0.25 D., which will not interfere

with vision. If the letters on the test card at 6 metres' distance can be read, the reading has been accomplished with the eye which is claimed to be blind. It is well to begin this test by placing a weak concave lens in front of each eye, so that if the patient closes the eye which he claims to be good, and attempts to look with the other eye in the beginning of the test, he will observe that he can see through the lens and will be thrown off his guard. The lenses are then changed simultaneously, a high convex being substituted for the weak concave in front of the eye which is claimed to be deficient.

4. The "blind" eye is covered and monocular diplopia is produced by placing a prism of 6 or 8 degrees' strength in front of the good eye, so that its apex corresponds to the centre of the pupil. The "blind" eye is now uncovered, and at the same time the prism is so moved as to cover the entire pupil. If the eye is not blind the individual will still see two images (binocular diplopia).

5. Snellen's test consists of a pane of glass with transparent colored letters, which are alternately red and green. A spectacle frame with a red glass in front of the "blind" eye and a green glass in front of the other is placed upon the patient, with instruction to read the letters on the pane of glass. If all the letters are read he must necessarily see with both eyes, whereas if the eye is really blind he cannot see the red letters.

6. A pencil is held half-way between the eyes and some small type, the patient being instructed to read. If he can read continuously and none of the words are missing he has binocular vision, and is using the eye which he pretends to be blind.

If an individual claims that both eyes are blind it is much more difficult to determine whether this is true or not. A test suggested by Priestley Smith and E. Jackson consists in placing a lighted candle in front of the individual to be tested, and holding a 6-degree prism with its base out in front of one eye. If vision is present in both eyes the eye behind the prism will move inward,

and on removal of the prism it will move outward, while the other eye remains fixed. In such cases, however, it is usually necessary to have the individual closely watched for some time.

Night-blindness (**Nyctalopia**, sometimes called **Hemeralopia**) is a condition in which the vision is good in the daytime or with bright illumination, but poor at night or in reduced illumination. It is a symptom of pigmentary degeneration of the retina, and is also observed in some of the cases of nerve and retinal changes following attacks of scurvy. The condition consists in a diminished sensibility of the retina, and is frequently found among residents in tropical countries. The field of vision for both form and color is, as a rule, concentrically contracted.

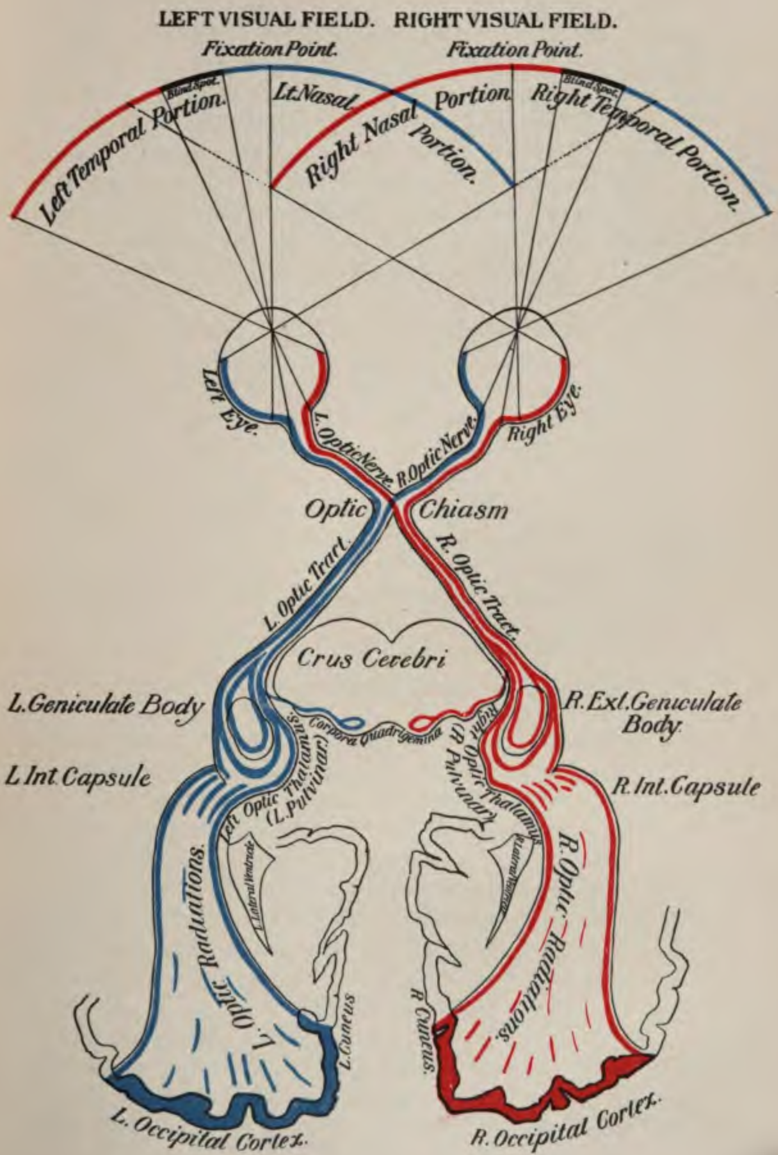
Treatment. The treatment consists in the internal administration of iron, quinine, and strychnine, and the employment of nourishing foods and good hygiene. If there has been a history of scurvy, the use of fresh vegetables and fruits and large quantities of lemon juice or lime juice will materially assist the condition.

Day-blindness (**Hemeralopia**, sometimes called **Nyctalopia**). This is a condition in which the patient sees better in diminished light than in the bright light of day. The field of vision is not concentrically contracted, and the condition frequently occurs as a symptom of chronic retrobulbar neuritis. In certain cases of nuclear opacities of the lens, or of central corneal scars, the patient sees better in reduced light on account of the corresponding dilatation of the pupil, but these are not the conditions of day-blindness as described.

Treatment. The treatment should consist in the administration of tonics and in the relief of any debilitated condition. In addition the patient should gradually accustom himself to the light.

Snow-blindness is a condition sometimes observed in regions in which there is considerable snow lasting for a long period, and is in reality a disease of the conjunctiva.

PLATE X.


LEFT VISUAL FIELD.
RIGHT VISUAL FIELD.
Fixation Point.
Fixation Point.
Blind Spot.
Blind Spot.
Left Temporal Portion.
Lt.Nasal Portion.
Right Nasal Portion.
Right Temporal Portion.
Left Eye.
Right Eye.
L. Optic Nerve.
R. Optic Nerve.
Optic
Chiasm
L. Optic Tract.
R. Optic Tract.
Crus Cerebri
L.Geniculate Body
R. Ext.Geniculate Body.
Corpora Quadrigemina
L Int. Capsule
R. Int. Capsule
Left Optic Thalamus (L.Pulvinar)
Right Optic Thalamus (R.Pulvinar)
L. Lateral Ventricle
L. Optic Radiations.
R. Optic Radiations.
L. Cuneus
R. Cuneus.
L. Occipital Cortex.
R. Occipital Cortex.

There is photophobia, blepharospasm, and some hyperæmia of the conjunctiva with pain. Occasionally corneal ulceration may accompany the condition. There is some congestion of the retina, and the pupils are small. The prolonged reflection from the surface of the snow may produce some contraction of the visual field, together with scotoma and night-blindness. The heat reflected from the surface of the snow produces the conjunctival condition. Smoked glasses should be worn as a preventive measure.

Colored Vision is sometimes observed by objects appearing in the form of one particular color. That which is most frequently observed is *erythropsia,* or *red vision,* in which all objects appear to be of a reddish color. It is most frequently observed after the extraction of cataract, and may last for a short or a long time. *Blue vision,* or *kyanopsia,* is also occasionally observed.

Treatment. The treatment is rest of the eyes, protection from bright light by means of tinted glasses, and the internal administration of the bromides.

HEMIANOPSIA.

The Optic Tracts. Fibres of the optic nerves pass backward to the *optic chiasm* and there semi-decussate, part passing backward on the same side, and part crossing to the opposite side of the brain. (See Plate X.) From the chiasm these fibres are continued backward as *optic tracts.* The optic tracts pass backward and outward to the primary optic ganglia, most of the fibres entering the *external geniculate bodies,* but a few radiations passing to the *anterior corpora quadrigemina,* and a part passing to the *pulvinar of the optic thalami.* A division of the fibres here takes place, a few going to the *nuclei of the third* or *oculomotor nerves,* which have to do with the reflex action of the pupils and the movements of the ocular muscles. The larger portion of fibres of the optic tracts, however,

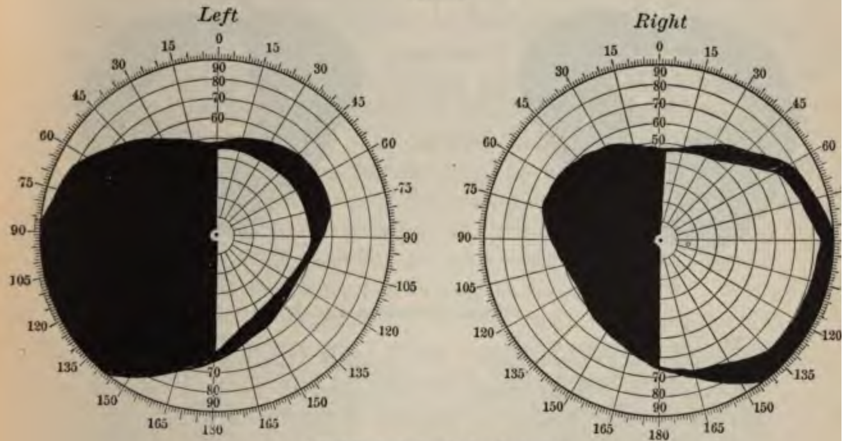
transfer their impulses to other fibres by means of which these impulses proceed backward to the *visual centre in the occipital lobe.* These fibres pass backward *through the internal capsule,* and terminate in the *cuneus* and the portion of the brain surrounding the calcarine fissure, which is known as the *visual centre of the brain.* If this centre for any reason is destroyed, the impulses proceeding backward by means of the optic nerves failing to produce sensations of any kind, there is total blindness. *The nerve supply of each retina is produced from both sides of the brain.* The fibres of the *right optic tract* pass to the *temporal half of the right retina,* and the *nasal half of the left,* and the fibres of the *left optic tract* pass to the *temporal half of the left retina* and the *nasal half of the right.* There is a *special set of fibres* in each optic nerve which passes to the *macula* of each eye.

Hemianopsia, or **Half Blindness,** is that condition in which objects are seen in one-half of the visual field, while in the other half there is partial or complete blindness. It is usually bilateral and due to disease or injury of some portion of the optic tract between the chiasm and its termination in the occipital lobe of the brain. It may affect one eye only if the lesion is in front of the chiasm, but the term is not ordinarily employed to describe the condition of half blindness, which may be due to disease of the eye itself.

Varieties of Hemianopsia. There are many varieties of hemianopsia depending upon the location of the lesion within the brain. *Right lateral hemianopsia* is that condition in which the temporal half of the right and the nasal half of the left visual field are blind, and is due to a lesion upon the left side of the brain involving the optic tract somewhere between the optic chiasm and the visual centre in the occipital lobe. *Left lateral hemianopsia* is that condition in which there is blindness of the temporal half of the left field and the nasal half of the right field, and is produced by a lesion on the right side of the brain somewhere between the optic chiasm and

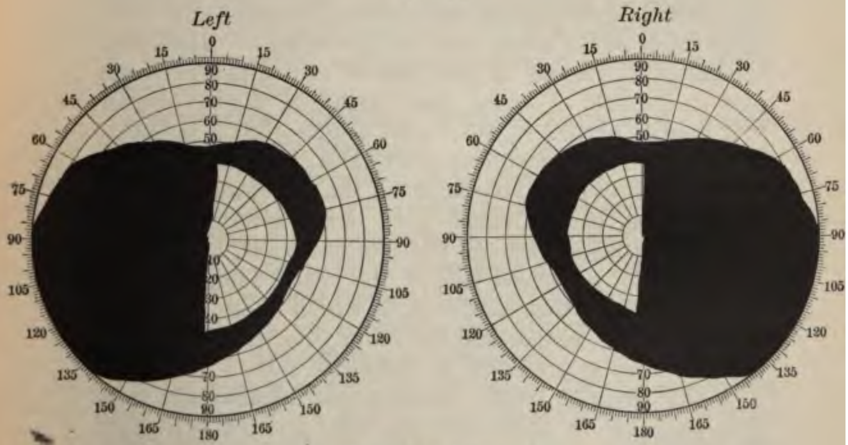
the visual centre in the occipital lobe. Instead of being called lateral hemianopsia these conditions are sometimes described as *right* and *left hemianopsia*, and sometimes

FIG. 89.



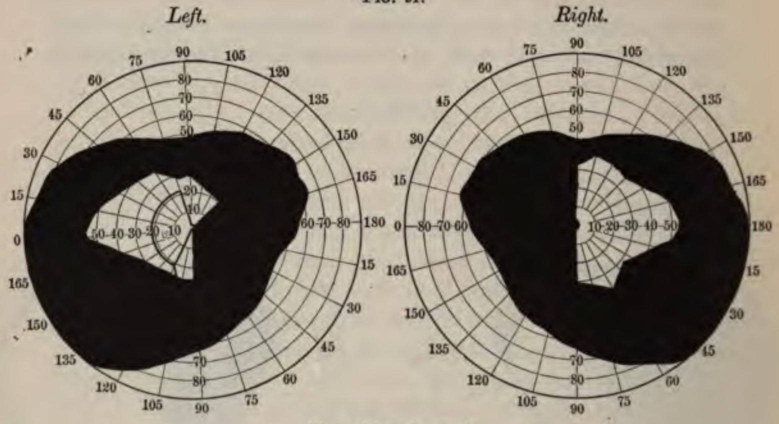
Left homonymous hemianopsia.

FIG. 90.



Bitemporal hemianopsia.

FIG. 91.



Binasal hemianopsia.

homonymous hemianopsia. *Bitemporal hemianopsia* is that condition in which there is blindness of both temporal halves of the visual fields, and is produced by a lesion affecting either the anterior or posterior portion of the chiasm. *Binasal hemianopsia* is that condition in which there is blindness of both nasal halves of the visual fields, and must be produced by symmetrical pressure upon both optic tracts at the outer sides of the chiasm. *Altitudinal hemianopsia* consists of the loss of the upper or lower half of the field of vision, and might be due to disease of a limited portion of the visual centres, but is probably most frequently a symptom of hysteria. In lateral hemianopsia the dividing line between the blind and the seeing portions of the visual field is not always vertical, and usually passes around the fixation point, leaving the latter in the preserved half of the visual field. *Hemiachromatopsia* is that condition in which there is loss of one-half of the visual field for colors, the ability to recognize them being preserved in the other half.

A few cases of **Double Homonymous Hemianopsia** have been recorded, in which both the right and the left lateral fields have been blind, there being preserved, however,

a small central field in each eye corresponding to the macular fibres.

Causes. The different varieties of hemianopsia may be produced by cerebral hemorrhage, tumor, or softening. In a few rare instances a sclerosed vessel has produced pressure upon some portion of the tract. If the lesion is situated in the cortical portion of the occipital lobe the hemianopsia may be partial or complete, and the blindness only relative. Such is the case, for example, in hemiachromatopsia. In cortical hemianopsia there are certain symptoms sometimes found, such as *alexia* (word-blindness), in which the patient is able to distinguish but not to understand written or printed characters, and *dyslexia,* or the inability to read more than a few words at a time on account of a feeling of disgust.

Hemianopic Pupil. In certain cases of hemianopsia the pupil does not react when the light enters it and falls upon the blind side of the retina, but as soon as it crosses the dividing line between the blind and seeing halves the pupil reacts promptly. This is sometimes called *Wernicke's hemianopic pupillary inaction symptom.* To make the examination the patient must be in a darkened room and the light must enter the pupil from a small source, a point of light being the best. If this symptom is found in hemianopsia it indicates a lesion in front of the primary optic centres.

Scintillating Scotoma (Partial Fugacious Amaurosis, Transient Scotoma). This is a condition which frequently occurs immediately preceding an attack of migraine. It usually begins as a small central dark spot from which run numerous irregular lines which are brilliant in character. Oftentimes there seems to be a shower of the most brilliant falling stars in the obscured portion of the visual field, and during this period the patient may observe when looking at a page of printed type that certain portions are lost. The field of vision may be contracted, and in some cases there may be complete homonymous hemianopsia. These symptoms may

last from ten minutes to an hour or two, and in some cases appear very frequently. As a rule, the headache does not present itself until after the subsidence of the symptoms just described. The cause is presumed to be due to some vasomotor changes in the vessels supplying the visual centres in the occipital lobe.

Treatment. If during an attack the countenance of the patient is exceedingly pale in appearance inhalations of nitrite of amyl will frequently give relief. In the variety in which the face is flushed it only increases the symptoms. Any existing refractive error should be properly corrected so as to remove all eyestrain, and the general health of the patient should be improved. As a uric acid diathesis seems to be a predisposing cause of this condition the employment of such drugs as will eliminate the uric acid from the system, as well as the use of diet to prevent its formation, should be employed. For this purpose 15 grains of piperazine, dissolved in a pint of water, plain or carbonated, and drunk at different intervals so that the amount is consumed every twenty-four hours, and continued for some weeks, is one of the best uric acid solvents.

CHAPTER XII.

DISEASES OF THE AQUEOUS AND VITREOUS.

Depth of the Anterior Chamber. The depth of the anterior chamber varies according to age and to certain conditions of the eye. In early childhood it is shallow because of the lack of full development of the eye, and also in old age because of the size of the crystalline lens. It is deep when the lens is absent, in keratoglobus, in myopia, and in serous iritis and cyclitis. It is shallow in glaucoma, in swelling of the crystalline lens, and in very high hyperopia.

Fig. 92.

Hemorrhage into the anterior chamber. (White Cooper.)

Changes in the Aqueous Humor. Whenever blood is found in the anterior chamber the condition is known as **hyphemia.** It may be very small in quantity, or the anterior chamber may be so completely filled as to distort the iris and the pupil. If the quantity is small it usually occupies the lower portion of the anterior chamber, and, if fluid, can be made to shift its position by inclining the head to one side. Vision is reduced according to the amount of blood present. It may occur spontaneously,

but is most frequently found as a result of injury, either accidental or operative.

Treatment. The treatment consists in the application of cold compresses, if there is a tendency to recur, or of hot compresses if seen late. Atropine may be instilled if there is no tendency to an increase of the intraocular tension, and a well-applied bandage will also assist in the absorption. Should the hemorrhage show a tendency to frequent recurrence, the internal administration of full doses of a good preparation of the fluid extract of ergot is of use. Calcium chloride internally, or hypodermic injections of gelatine may be tried in persistent cases.

Hypopyon is a term applied to the appearance of pus in the anterior chamber. Like blood in the anterior chamber, it is usually found in the lowest part, and will change its position with the movement of the head unless it is very thick in character. It is observed in infectious corneal ulcers and purulent disease of some portion of the uveal tract. It is said to be much less serious in children than in adults.

Treatment. The treatment consists in the removal of the cause and in the use of atropine and hot fomentations. In adults it is usually necessary to evacuate the pus by paracentesis of the anterior chamber.

Occasionally a *foreign body*, a *dislocated lens*, a *cysticercus* or *filaria* is found in the anterior chamber.

Congenital Anomalies of the Vitreous. Persistent Hyaloid Artery is occasionally observed as an anomaly of the vitreous humor, and appears as a grayish vessel which extends forward into the vitreous from the optic disk. In some rare cases it extends as far as the hyaloid membrane. **Fibrous membranes** are also sometimes met with.

Muscæ Volitantes. This term is used to describe that condition in which numerous small spots or motes are observed floating before the eyes, and in which an ophthalmoscopic examination reveals no pathological changes. They are observed more distinctly in bright

light or when looking at bright substances, like the surface of glazed paper, and are especially annoying to some people in using a microscope. They may appear as small specks or as twisted strings, while some present an appearance like tube casts. Their production is by shadows upon the retina of cells which are normally found in the vitreous, and they are frequently observed in patients who are debilitated or who are suffering from digestive or hepatic disease. While exceedingly annoying they are of no pathological significance.

Treatment. The treatment is to build up the general health and, by the administration of a cholagogue, to obtain free action of the liver. In those cases in which large pupils admit so much light as to make the condition particularly noticeable and annoying a very weak solution of eserine (gr. $\frac{1}{40}$–℥j) may be instilled twice a day. Refractive errors should be corrected and any neurotic condition removed.

Vitreous Opacities. Any impairment of the transparency of the vitreous interferes to a greater or lesser extent with visual acuity. As a result of various pathological conditions not only in the vitreous itself, but in the surrounding structures, the vitreous humor becomes the seat of numerous opacities of various sizes and shapes.

Symptoms. The symptoms are principally those of some variety of visual disturbance. If the opacities are very thick and numerous a large part of the central vision may be obliterated. If, however, only a portion of the vitreous is occupied, or the opacities remain thin, the patient may complain only of foggy vision together with numerous grayish and blackish specks floating before the eyes. The opacities may be merely small dots not larger than a pin's head, or they may be very large and of irregular shapes, sometimes resembling spiders in appearance; that is, there is a large central opacity with numerous prolongations like the legs of a spider. The opacities may also be membranous in character as the result of previous hemorrhages, or they may appear as strings waving

throughout the vitreous. If they are so minute as to resemble dust the opacities themselves cannot be isolated in the examination, but the whole vitreous appears thick or muddy. This variety is usually found in disease of the retina and choroid due to syphilis. The opacities may be either fixed or mobile, according to whether the vitreous still retains its shape or has become disorganized and fluid in character.

Diagnosis. The diagnosis is made by examination with the ophthalmoscope, each portion of the vitreous being carefully studied by the introduction of lenses of various strengths before the eye. If the patient is directed to make a quick movement of the eye, and the vitreous is fluid, thus permitting the opacities to move about, they will be seen to float up and down through the vitreous and, when the eye is steadily fixed for a moment, to settle toward the lowest portion.

Causes. The causes of vitreous opacities are traumatism producing hemorrhage into the vitreous, and, more frequently, disease of the surrounding structures. Affections of the ciliary body, retina, choroid, etc., are apt to involve the vitreous to a certain extent, and thereby produce vitreous opacities.

Prognosis. The prognosis depends upon the stage in which the patient is placed under treatment, as well as the cause giving rise to the condition. The best result is obtained, as a rule, in syphilitic opacities and those following hemorrhage, though it may take many months to clear them up. If the disease of the surrounding structures has been relieved the patient may be assured, as a rule, that the opacities will not become greater. If, however, this is not the case, the opacities are likely to increase. Large, well-formed opacities cannot be removed.

Treatment. The treatment must be directed principally to the cause of the opacities. Should there be a history of syphilitic infection mercury and iodide of potassium give the best results. In almost any form of opacity the

same drugs administered for their so-called alterative effect are of service. Profuse diaphoresis by means of hypodermic injections of pilocarpine is also of much service. If the opacities are very numerous and the surrounding structures are markedly involved the eyes should be rested and protected from strong light.

Synchysis Scintillans is a name which has been given to the appearance of numerous cholesterine crystals distributed throughout a fluid vitreous. Sometimes crystals of tyrosine and the phosphates are included under this heading. The condition is usually found in eyes more or less degenerated, but in which, nevertheless, excellent vision is frequently preserved. The ophthalmoscope reveals numerous glistening, shining crystals floating throughout the vitreous upon the least movement of the eyeball, looking not unlike a shower of minute granules of silver or gold. It cannot be removed by any treatment.

Hyalitis is a term employed to designate an inflammation of the vitreous humor, and usually arises from inflammation of one of the surrounding structures.

Suppurative Hyalitis is produced by some traumatism from which the vitreous becomes infected, or results from a purulent inflammation of the choroid. In this condition a yellowish reflex is seen when looking through the pupil, and the intraocular tension is diminished. There may be accompanying inflammation of the iris and ciliary body. If the pus is circumscribed the condition presents an appearance so similar to that of glioma that it has received the name of *pseudoglioma*. The *non-suppurating inflammation of the vitreous* is that variety which leads to the formation of opacities which may become permanent.

Treatment. The treatment consists in the removal of the cause, as hyalitis is a symptom rather than a disease of itself. If pus should be discovered in the eyeball, enucleation will usually be necessary. In the non-suppurative variety the treatment described under vitreous opacities is to be employed.

Hemorrhage into the Vitreous arises from some one of the surrounding structures, and may be due to traumatism. Occasionally cases are met with which seem to arise spontaneously. The patient may observe red vision when looking at bright objects, and the ophthalmoscope shows dark masses in the vitreous which may appear red by reflected light.

Treatment. The treatment consists of rest both for the eyes and for the body. Confinement to bed with the head propped up high, the application of cold compresses to the eye, and the use of such remedies as will lower the vascular tension should be promptly employed. At a later period pilocarpine sweats and the internal administration of the iodides will assist in the absorption of the clot. The general health must be improved, and any vascular or blood disease removed, if possible.

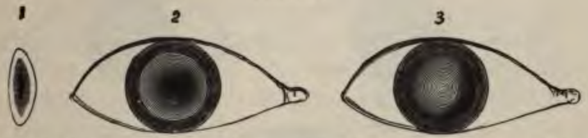
Parasites in the Vitreous. Several parasites have been described as having been found in this location, among them *filaria*, *hydatids*, and *cysticerci*, the latter being the most common. The *cysticercus* is usually observed as a round, whitish cyst to which is attached the long neck. If alive the head can be seen moving to a slight extent independent of the ocular movements. If it is dead it is not so easily recognized, as it becomes covered with lymph. The eye is likely to become blind if the parasite cannot be removed.

CHAPTER XIII.

DISEASES OF THE CRYSTALLINE LENS.

Cataract. Cataract is a term which is usually employed to describe any opacity of the crystalline lens or its capsule. It is more frequently employed, however, to describe those cases in which the opacity of the lens is extensive and in which vision is much impaired.

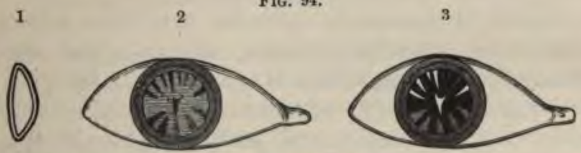
FIG. 93.



Nuclear cataract. 1. Section of lens; opacity densest at centre. 2. Opacity as seen by transmitted light (ophthalmoscope mirror) with dilated pupil. 3. Opacity as seen by reflected light (focal illumination). The pupil is supposed to be dilated by atropine. (Nettleship.)

Varieties of Cataract. The following definitions of the many varieties of cataract which have been described from time to time are mostly self-explanatory:

FIG. 94.



Cortical cataract. References as in preceding figure. (Nettleship.)

A *lenticular cataract* is one in which the lens only is opaque. A *capsular cataract* is one in which the capsule

only is opaque. A *capsulo-lenticular cataract* is one in which both capsule and lens are opaque. *Senile cataract* is that variety which presents itself in old age and is subdivided into *nuclear senile cataract* (Fig. 93) if the nucleus of the lens is principally involved, and *cortical senile cataract* (Fig. 94) if the cortex is principally involved. *Congenital* or *juvenile cataract*, the variety found at birth, may be subdivided into *complete* or *partial*, according to whether the whole or only a part of the lens is involved. *Partial congenital cataracts* are again subdivided into *lamellar* or *zonular* (Fig. 95), and into *pyramidal* or *polar* (Figs. 96 and 97). A *zonular* cataract is one in which there are

FIG. 95.

Lamellar cataract. 1, 2, 3, as before. 4 shows *slight* grayness of the undilated pupil owing to the layers of opacity being deeply seated. (Nettleship.)

opaque layers in the lens surrounding the clear central portion. A *polar* cataract is one in which there is an opacity of the anterior or posterior pole of the lens. *Complicated* or *secondary cataracts* are those arising as the result of some pre-existing affection, and may be *anterior* or *posterior polar*, or *complete*. *Anterior* and *posterior polar cataracts* are those in which the opacities involve only the anterior and posterior poles of the lens (Figs. 96 and 97). A *traumatic cataract* is one which results from traumatism. The so-called *after-cataract* is an opacity of the lens capsule and remaining débris following an operation for cataract. Cataracts are also *primary* or

secondary, partial or *complete, stationary* or *progressive.* They are also *hard* or *soft*, according to whether there is a large or small nucleus. They are also at times fluid if they have become over-ripe with liquefaction of the cortex, and are called *Morgagnian cataracts.* In color they may be *black, white,* or *amber.*

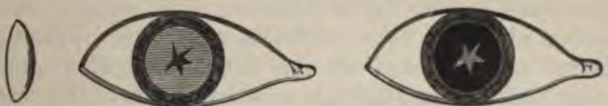
Symptoms of Cataract. The first symptom of cataract observed by the patient is some interference with visual

FIG. 96.

Anterior polar cataract, seen from the front and in section. (Nettleship.)

acuity, the degree of this interference depending upon the position of the opacity and the variety of cataract. An opacity in the centre of the lens will naturally interfere much more markedly with vision than a similar opacity near the periphery of the lens. If the cataract is progressive, vision becomes more and more impaired until finally, in many cases, there is only perception of light remaining.

FIG. 97.



Posterior polar cataract. References as before. (Nettleship.)

In the beginning there may be numerous spots observed on account of the striæ and opacities of the lens. There may be polyopia or monocular diplopia observed occasionally on account of the irregular refraction due to the opacities. Myopia sometimes develops in the early stages because of the swelling of the lens. On account of this condition the patient is sometimes enabled to do without his reading glasses and congratulates himself that he

has obtained his so-called "second sight." The condition, however, is always a sign of swelling of the lens and is the beginning of lenticular opacity. There may be some pain and hyperæmia of the conjunctiva because of the effort necessary in the use of the eyes. Slight photophobia is also sometimes complained of. In nuclear cataracts the patient sees better at night, or in a darkened room on account of the dilatation of the pupil. The anterior chamber may be normal in depth, or it may be shallower or deeper, according to whether the lens is swollen or small. The color of the pupillary space, instead of appearing black, appears grayish or amber-colored, unless the cataract should be the so-called "black cataract," when the pupil is dark.

Causes. The cause of cataract in the vast majority of cases is probably some condition which interferes with the nutrition of the lens. In commencing senile cataract an examination of the fundus will frequently show vascular changes in the periphery or some other disturbance of the choroid. Beyond disease of the uveal tract, age, and some constitutional diseases, as diabetes, but little is known of the causes of cataract. It may be produced by heat, and is frequently met with in glass-blowers and puddlers. Heredity is also a factor in its development. A lowered vitality following some severe systemic affection also acts as a predisposing cause. Traumatic cataract arises because of the entrance of the aqueous humor between the lens fibres which destroys the refractive power of the lens and ultimately dissolves its fibres.

Diagnosis. There are no inflammatory symptoms by which cataract may be diagnosed. The opacity of the lens must be determined by examination by means of direct and oblique illumination. If an ophthalmoscope is employed the opacities in the lens will be seen as black dots on a reddish background. If the lens is entirely opaque it may appear as a grayish-white substance, blocking out the view of the fundus, there being no red glare from the latter. The pupil should always be dilated in

making an examination of the lens, so that the periphery, as well as the centre, may be carefully studied. Oblique illumination shows the spots and striæ, as well as a complete opaque lens, as grayish or grayish-white. Certain forms of nuclear cataract present an amber tint, and in the so-called black cataract the color with oblique illumination is of a deep brown.

Senile Cataract. Senile cataract is usually associated with advanced age; hence the name senile. It is the most common form of cataract, and is usually met with in patients over fifty years of age, though occasionally observed as early as the thirty-fifth year.

Symptoms. The principal symptom observed by the patient is a gradual impairment of vision. At first there may be fogginess of vision, or the appearance of a few black striæ before the eyes, which, at a later period, progress gradually. Sometimes there remains only the perception of light; in other cases the vision is never lost beyond the counting of fingers held a few inches from the eye. The early impairment of vision may be due more to some change in the refraction than to opacity. This is on account of the swelling of the lens, which produces a temporary myopia, and, if the patient has been reading with convex lenses, permits him to discard the use of glasses, or at least to adopt weaker lenses. The condition is sometimes called "second sight."

The opacity may begin in the centre or in the periphery of the lens. If the centre, or the nucleus, is the part involved the patient will see better in a moderate amount of light because of the corresponding dilatation of the pupil. If the opacity begins at the periphery there are usually observed a number of striæ extending toward the centre. Instead of the form of opacities just described, in some cases there are noted numerous opaque spots throughout the whole cortical portion of the lens, which afterward coalesce, producing opacity of the whole lens. The condition of the lenticular opacity is best studied by means of the ophthalmoscope with a strong convex lens.

We speak of a cataract as being *incipient* when the opacity is partial and some useful vision is still present through clear portions of the lens, and of the *maturing stage* when the opacity has increased in extent but is still incomplete. In this stage the lens is swollen by the absorption of fluid, and the patient may obtain his so-called "second sight." We speak of the *mature stage*, or of a *ripe cataract*, when the lens loses most of its fluid, has become entirely opaque, and has shrunk almost to its normal size. In the *hypermature* or *over-ripe* stage, the lens has shrunk, or the cortex has become liquid, the nucleus sinking to the bottom. This variety of cataract presents a milk-white appearance, with an apparent reflex from the nucleus in the lower part. At a still later date there may be present deposits of lime salts, together with marked thickening of the capsule.

FIG. 98.

Shadow of the iris seen from in front in immature cataract.

If the cataract is "*ripe*" or *mature*, the opaque lens fills the pupillary space, no clear lens substance appearing between the opaque portion and the margin of the pupil; if it is *immature* some clear lens substance will be detected by oblique illumination, and the iris will throw a shadow upon the lens when a lighted candle is held as in Fig. 98. A red reflex from the fundus or bright sectors in the lens also indicates immaturity.

Diagnosis. In every case of suspected cataract an examination must be made by means of the ophthalmoscope, and if there is no serious contraindication the pupil must be dilated to ascertain the extent of the lenticular opacity.

Prognosis. The prognosis in senile cataract is that it will in the course of time, if the patient lives long enough, become complete. It is impossible, however, to state definitely how long this period will be. Nuclear cataracts, as a rule, mature more quickly than cortical. There are many cases also in which a few striæ appear in the lens which never advance to complete opacification. This is especially true in myopes and in elderly people, in whose lenses a few striæ are found, usually in the lower inner quadrant. Such a condition may not change for many years. It is, therefore, improper to frighten all patients whose lenses show a moderate amount of opacity by stating that they will perhaps ultimately be blind from cataract. This information may be given a near relative if desired. In a few rare instances opacities of the lens have disappeared spontaneously.

Treatment. The treatment of immature cataracts consists in the relief of all eyestrain by the proper correction of any existing refractive error and in making a change in the glasses as frequently as the swelling of the lens and the formation of opacities demand. In those cases of nuclear cataracts in which glasses do not seem to be of much use the patient's vision may be somewhat improved by the use of a weak mydriatic. Inasmuch as it is generally believed that some disturbance of the nutrition of the lens is productive in the formation of cataract, the internal administration of the so-called alteratives is of benefit. Very small doses of bichloride of mercury, together with iodide of sodium, or potassium, apparently allay the congestion of the choroid, and thereby increase the nutrition of the eye. It is better to allow the patient to employ the eyes moderately during the process of the formation of cataract, as it does not give so much opportunity for brooding over the condition.

When a cataract is immature and exceedingly slow in its progress toward maturation operations have been advised for producing this result artificially. As a rule, these

operations are not to be recommended, because after the artificial ripening of a cataractous lens there is frequently some difficulty in its extraction. Indeed, many operators prefer to remove an immature cataract rather than to perform the operation for artificial ripening, with subsequent removal.

Many *ripening operations* have been advocated, some of which consist of division of the anterior capsule by means of a needle, others of massage of the lens fibres either with or without an iridectomy. A small iridectomy may be performed according to the methods described elsewhere, and with a spatula the anterior portion of the lens may be gently rubbed through the cornea or by its direct introduction into the anterior chamber. If the massage is performed through the cornea a paracentesis of the anterior chamber will suffice. The artificially matured lens is usually extracted as soon as it has become opaque, usually a few weeks later.

A carefully performed small iridectomy is sometimes of service also in improving the vision in nuclear cataracts.

The extraction of mature or ripe cataracts is usually accomplished by one of two methods, viz., the *simple extraction*, or *extraction without iridectomy*, and *combined extraction*, or *extraction with iridectomy*. Before attempting any of the operations for cataract there are several conditions of the eye which must be studied. The *probable condition of the interior of the eye* must be ascertained by making an ophthalmoscopic examination of the other eye, if this is possible, and by testing the patient's *light field* and *light projection*. This is done by sitting the patient about 1 metre distant from a lighted candle in a darkened room, and with one eye covered and the cataractous eye constantly looking at the candle, a second candle is brought into the field of vision from each side as well as from above and below, the patient not only stating when he sees two lights, but locating the second light. If the patient is unable to do this there may be certain changes inside of the eye, as, for example, patches

of choroiditis, retinal detachment, optic nerve atrophy, or even glaucoma.

If there is no light perception the patinet should not be operated upon, as the prognosis for acute vision after operation depends largely upon a good light field and light projection. It is impossible by means of these tests to detect small patches of disease of the fundus in the neighborhood of the macula.

The *condition of the refraction* should be determined, if possible, for the reason that in high myopia with fluid vitreous and vitreous opacities the prognosis is not so good as in eyes not thus affected.

The *condition of the iris,* and whether it reacts to light or to a mydriatic, should also be taken into consideration.

Age should not prevent the performance of an operation, provided the patient is in good physical condition. If the patient is not in good condition physically he should be improved as much as possible before the operation is undertaken.

The *condition of the surrounding parts* should also be good, there being no unhealthy discharges. These various points are further discussed in Chapter XIX.

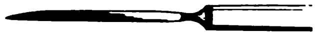
Combined Extraction of Cataract (Extraction with Iridectomy). The eye and all sourrounding parts should be prepared according to the rules given in Chapter XIX.

The instruments required are an eye speculum (Fig. 105), fixation forceps (Fig. 103), a Graefe cataract knife (Fig. 99), iris forceps (Fig. 107), iris scissors (Fig. 104), a cystotome (Fig. 100), a Daviel's spoon (Fig. 100), and a spatula (Fig. 106). In addition it is well to have in readiness a wire loop (Fig. 101), a lid elevator (Fig. 4), and a pair of capsule forceps (Fig. 102).

The operation is divided into five stages consisting of the following procedures: 1. The making of the corneal section. 2. The iridectomy. 3. The capsulotomy. 4. The delivery of the lens. 5. The toilet of the wound.

The Corneal Section. With the fixation forceps in one hand, the eye is seized below the cornea and rotated

FIG. 99.



Cataract knife.

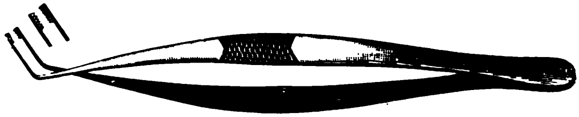
FIG. 100.

Daviel's spoon and cystotome.

FIG. 101.

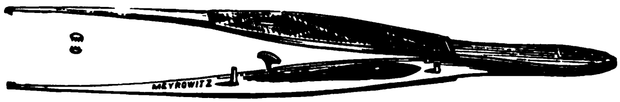
Lens scoop.

FIG. 102.



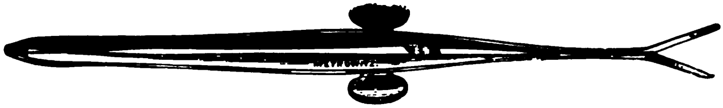
Capsule forceps.

FIG. 103.



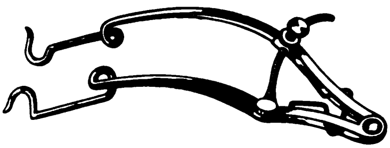
Fixation forceps.

FIG. 104.



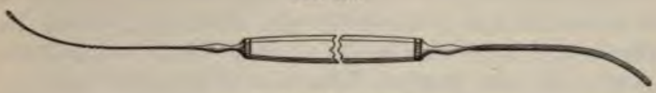
Iris scissors.

FIG. 105.



Eye speculum.

FIG. 106.



Probe and spatula.

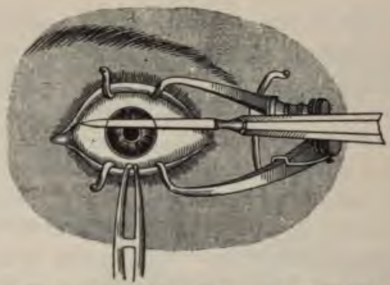
FIG. 107.

Iris forceps.

downward, while in the other is lightly held the cataract knife at some distance from the blade, so that the full length of the latter can be employed. The point of the knife is entered on the temporal side of the eye, exactly at the apparent corneo-scleral junction, and at a point 3 mm. below a tangent to the uppermost portion of the cornea. The knife may be entered perpendicular to the plane of the cornea, or in the direction of the counter-puncture, in the latter case care being taken to avoid passing it between the corneal layers. After the knife is entered into the anterior chamber it is thrust carefully across and brought out at a point diametrically opposite the point of entrance. The blade is pushed forward as far as the heel, or until the point almost touches the nose, when, by a few to-and-fro sweeps, making the edge cut in both directions, and keeping in the same plane, parallel to the iris, in which the knife is entered, the upper portion of the cornea and sclera are divided exactly at their apparent junction. If the section is made as above described there will result a small conjunctival flap. Should it be desired to make a larger one, or to avoid the conjunctiva altogether, the edge of the knife is turned slightly backward or forward as soon as the cornea and sclera have been divided and before the conjunctiva is cut.

Iridectomy. The fixation forceps are now handed to an assistant who rotates the eye downward, when the iris forceps held in one hand, the blades closed, are passed into the anterior chamber to a point near the pupillary margin if the iris has not already prolapsed into the wound. The blades are then opened and the handle dipped slightly downward and forward, thus throwing the tip of the forceps into the iris tissue, when the blades are again closed and the seized iris withdrawn. A pair of iris scissors in the disengaged hand are held in readiness, the blades open, and as soon as the iris is with-

FIG. 108.



The corneal section in cataract extraction. Puncture and counter-puncture have been made. The section will pass in its whole extent exactly through the transparent margin of the cornea, the knife remaining in the same plane throughout. Slightly modified from de Schweinitz. (Ellett.)

drawn from the anterior chamber, it is excised with one or two snips. The coloboma thus formed should be small and narrow, although in von Graefe's original operation the amount of iris excised corresponded to the length of the wound. A small coloboma, however, is sufficient for all purposes for which the iridectomy is performed, and presents a much better appearance from an æsthetic standpoint. In addition, there is less dazzling than would occur from a large coloboma, as a smaller quantity of light enters the eye.

Capsulotomy. The assistant is now relieved of the forceps, which are again held by the operator, who, at the

same time, passes a cystotome into the anterior chamber held flatwise in such a manner as not to injure the iris or cornea. The instrument is carried as far as the lower margin of the pupil, when it is turned with the cutting point toward the capsule. A transverse opening is now made in the capsule by giving to the instrument a lateral movement, and then by withdrawing the instrument upward a perpendicular opening is made at right angles to, and beginning at the middle of, the transverse cut, and terminating in the upper periphery of the capsule.

Other methods of opening the capsule are employed by different operators. Some prefer to open the capsule in the shape of an upright T, or of a V, or of an inverted Λ; others, Knapp for example, prefer to make an extreme peripheral opening by passing the cystotome beneath the iris in the neighborhood of the periphery of the capsule. Some authors even prefer to employ capsule forceps to assist in the removal of the capsule. No matter what method is employed, care must be exercised to prevent injury to the iris or the accidental dislocation of the lens.

Delivery of the Lens. In this stage the operator may, or may not, continue to hold the eye with the forceps, as he pleases, depending largely upon whether his patient is quiet or nervous. The eye should be made to rotate downward, when pressure is made on the lower margin of the cornea by means of the convex surface of Daviel's spoon, which is made to follow the lens upward as it is being expelled. The spoon should be made to pass entirely across the cornea lying above its primary position, and the pressure at first should be toward the centre of rotation of the eye, so that the upper edge of the lens may be tilted forward, and then continued upward following the lens. The spoon must not be removed from the eye until the whole depth of the cornea has been passed over, as this procedure will oftentimes bring out some of the cortical matter which has broken off from the lens in its passage. Judgment must be exercised in the amount of

pressure to be made, as there is always some danger of a prolapse of the vitreous. As soon as the equator of the lens has passed beyond the lips of the wound the pressure is to be somewhat diminished. If the edge of the lens seems to catch at the lips of the wound its delivery may be assisted by slightly depressing the posterior lip by gentle pressure with a spatula at the same time that pressure is being exerted below.

Toilet of the Wound. Any remaining cortical matter and pieces of capsule are now cleared from the anterior chamber, or from between the lips of the wound, by gently stroking the cornea with the back of the spoon, or

FIG. 109.

Delivery of the lens. The lens is presenting in the wound, iridectomy and capsulotomy having been performed. (Ellett, after de Schweinitz.)

by passing the spatula along the corneal section. If the pillars of the coloboma have prolapsed, or seem to have a tendency to prolapse, they are replaced in their proper positions by means of the spatula. If there seems to be any tendency for the vitreous to prolapse, it is better to remove the speculum from beneath the lids, and to expel any remaining cortical matter by gentle pressure upon the eyeball through the lower lid. The lips of the wound are approximated and both eyes are now dressed by placing over them a few pads of sterile gauze moistened in a weak bichloride solution. Over these pads is now placed sufficient absorbent cotton to fill in the depression produced by the orbital ridge and the nose. A few strips

of isinglass plaster may be added to hold these dressings in place, or the figure-of-eight bandage may be applied. It is safer in most cases to place over this some one of the protective masks (Fig. 188) to prevent injury to the eye during sleep or in moving the head about.

Modifications in the Operation. There are many modifications in the situation of the corneal section, some operators preferring to make it just beyond the corneal limbus, and others slightly within the clear cornea. If one is delivering a large lens the section must be made slightly larger than if the lens is known to be small. Most operators prefer to make the corneal section in the upper portion of the cornea, though by a few it is placed in the lower portion. A few operators recommend a suture for closing the corneal section.

In preparing the toilet of the wound some surgeons irrigate the anterior chamber with normal saline solution by means of a syringe, for the purpose of washing out any remaining cortical matter. If this procedure is practised it should be remembered, as pointed out by Knapp, that the flow of the solution employed should be over the wound from within outward, and not the reverse; otherwise some of the blood and cortex might be forced into the anterior chamber.

Accidents Occurring during Extraction of Cataract. There are many accidents that may occur during the performance of this operation, the chief of which are the following:

The knife may be entered with its cutting edge in the wrong direction. If this has occurred the knife should be withdrawn, and if the aqueous humor escapes, as it most likely will do, the operation will have to be postponed until the anterior chamber re-forms.

The point of counter-puncture may not be diametrically opposite the point of puncture; it may be either too far in front, or too far behind the corneo-scleral junction. If the operator can see that the point of the knife is not in the proper position to make the counter-puncture and

it has not already been started through the corneo-scleral tissue, it should be slightly withdrawn and entered at the proper place. If the counter-puncture has been made before the error is discovered, the section must be completed as if the accident had not occurred. It must always be borne in mind that the conditions under which the knife is passed across the anterior chamber are somewhat deceptive, as the blade of the knife is under water behind the cornea, which produces a certain amount of refraction.

The iris sometimes falls in front of the knife before the corneal section is completed, and if it should do so the section should be finished as if the accident had not occurred, a proper iridectomy being made later. To prevent this accident, Noyes recommended to let the heel of the knife quickly cut the temporal side of the wound in withdrawing it after the counter-puncture has been made.

The wound may be too small for the lens to pass through. This is a very unfortunate accident, and if it should occur the wound must be enlarged with a pair of blunt-pointed scissors or with a small knife. In making a section of the cornea it should be remembered that the inside opening is much smaller than the outside opening, and that the size of the lens to be passed through it must be given due consideration.

The laceration of the capsule may not have been sufficiently extensive to permit the escape of the lens, so that when pressure is made on the lower part of the cornea the lens fails to present at the wound. Under these circumstances the cystotome should be re-introduced and the opening enlarged.

The lens may become dislocated. If the dislocation is only partial, the speculum should be removed and gentle pressure made through the closed lids for a moment, when the lens frequently falls into place and can be delivered in the usual manner. If the dislocation is complete and into the vitreous, or if the lens should fail to right itself, it must be delivered by means of the

wire loop, which is gently placed behind it, and as soon as the lens falls into the cavity of the loop it is lifted out.

The vitreous sometimes escapes before, sometimes after, the expulsion of the lens. If the accident occurs before the expulsion of the lens, the latter should be delivered as quickly as possible with the wire loop. If it occurs after the delivery of the lens, the prolapsed portion should be excised and the lips of the wound gently cleared. All pressure must be avoided in either case.

After-treatment. The wound heals more quickly if the patient can remain quiet, lying upon his back as much as possible for the first twenty-four hours. If the patient cannot possibly lie in one position for so long a time, and must turn, it is better for him to turn toward the unoperated side. Soft food should be employed to prevent a separation of the lips of the wound by chewing movements. The dressings are changed daily, the edges of the lids being wiped with warm sterile boric acid solution; but if there has been no discomfort or pain, or if there is no distention of the veins of the lids of the eye which has been operated upon, the eye is not opened for inspection until the time of making the second dressing. Inasmuch, however, as there is frequently an accumulation of tears in the conjunctival sacs, which produce more or less annoyance, it is well to evert slightly the lower lid and permit them to escape. It is also better at the time of the first or second dressing to instil a drop of a sterile solution of atropine to prevent the formation of synechiæ. At the end of forty-eight hours a rapid inspection of the eye may be made by means of candle light. In from four to six days' time the bandage may be left off the unoperated eye, and in from ten days to two weeks' time it may be left off the operated eye, provided there are no severe complications. When the bandage is removed the eye is protected from strong light by means of dark glasses and a shade. The bowels need not be moved for three or four days after the operation,

and if a natural movement should occur before this time the patient must be cautioned not to strain. Glasses are prescribed in from four to six weeks, if the eye has become perfectly quiet.

Complications in the Healing Process. In most patients *pain* presents itself as an early sign of any complication in the healing process. When the eye is inspected it may be found simply to have been produced by a nipping of the iris by the lips of the wound, and as soon as this is released the pain ceases. Pain may also indicate a more severe complication, such as *intraocular hemorrhage.* If this condition should be met with it usually results in the loss of the eye. It may come on immediately after the operation or somewhat later, being accompanied by considerable pain, the dressings being saturated with blood. Upon removal of the dressings a clot will be seen between the lips of the wound. The patient should be made as quiet as possible by a hypodermic injection of morphine; the head of the bed should be elevated, and antiseptic dressings applied. If, however, the hemorrhage should continue and pain become very severe, enucleation will be required. An *iritis* or *iridocyclitis* sometimes follows the operation for extraction of cataract, and must be treated as these conditions are treated under other circumstances. *Suppuration of the wound* is also met with, and is accompanied by pain, œdema of the lids and conjunctiva, some haziness of the cornea and aqueous humor, and the formation of a small sloughing ulcer at the wound margins. The process may be limited and terminate in recovery with a closed pupil, or it may extend into the interior of the eye and produce panophthalmitis. When met with, the lips of the wound should be irrigated with a solution of bichloride of mercury, the conjunctival sac thoroughly cleansed, and the line of incision cauterized with the nitrate of silver stick, or with the actual cautery. The treatment is practically that of a sloughing ulcer of the cornea. *Glaucoma* is also occasionally met with after extraction of cataract, but receives the usual treatment of glaucoma.

Simple Extraction of Cataract (Extraction without Iridectomy). At the present time there seems to be a tendency to return to the old operation of extraction without iridectomy. The operation itself differs from that which has just been described in that no iridectomy is performed, and the corneal section must be somewhat larger to permit of the delivery of the lens. Instead of making a three-millimetre flap at the corneo-scleral junction, as is done in the extraction with iridectomy, in simple extraction a four-millimetre flap is employed and the knife is entered just within the clear cornea. With these differences the operative procedures are similar to those above described.

The difficulty with this operation, as urged by some operators, is the marked tendency to prolapse of the iris. If this should occur within a short time after the operation has been performed the eye must be again anæsthetized and the prolapsed portion excised, thus converting a simple extraction into a combined extraction. If, however, the iris prolapses at a later stage it is agreed by most operators that it is better to leave it alone. The operation of simple extraction should not be attempted in eyes in which there is any complication that might give rise to an iris prolapse.

Discission of After-cataract. After the operation for the extraction of cataract either by the simple or combined methods, there frequently remains a thickening of the capsule, which is termed an after-cataract, and which interferes more or less with distinct vision. In such cases the capsule may be split by the operation of discission, thus making a pupil through which the patient can see more distinctly.

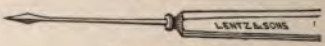
In performing this operation the following instruments are required: An eye speculum (Fig. 105), a pair of fixation forceps (Fig. 103) and a cataract needle, which may be either a knife-needle (Fig. 110) or a spear-shaped needle (Fig. 111). The pupil is widely dilated with atropine so that the capsule is thoroughly exposed, and

the eye is anæsthetized with cocaine or holocaine. Exceedingly bright light is required in order to see the capsule distinctly, and for this reason many operators prefer to perform this operation in a dark room illuminated by artificial light, which is thrown upon the eye by means of a condensing lens. The eyeball is seized with the fixation forceps and the needle entered at the outer side of the cornea a few millimetres from the limbus. It is passed directly across the anterior chamber as far as the margin of the iris, when it is thrust through the capsule and, with the cornea as a fulcrum, the handle of the knife is elevated and at the same time the needle slightly withdrawn so as to make a horizontal incision through the capsule. The handle is next depressed and the point of

FIG. 110.

Knife needle.

FIG. 111.



Lance needle.

the needle thrust through the upper portion of the capsule at the pupillary margin, when a downward incision is made to meet the horizontal incision. The needle is now thrust through the lower portion of the capsule and an upward incision made as far as the horizontal incision. These incisions are, therefore, in the form of a cross, and the capsular membrane, being more or less elastic, retracts, the edges curling somewhat, thus forming an opening in the centre. If the capsule is exceedingly thick and tough it is better to employ two needles in order to prevent dragging upon the ciliary bodies. These are entered through each side and made to pierce the capsule in the centre when, by approximating their handles, a rent is made.

In those cases in which the pupil closes because of severe iridocyclitis after removal of the lens (Fig. 112),

vision may sometimes be improved by means of an *irido-cystectomy.* A Beer's knife is passed through the lower part of the cornea into the anterior chamber and made to penetrate the iris about 2 mm. higher than the corneal opening. The iris is then withdrawn by means of a blunt hook and excised.

Aphakia. This term has been applied to that condition of the eye in which there is an absence of the crystalline lens; hence all eyes after the extraction of cataracts are aphakic. The focal power of the crystalline lens is ordinarily about + 10 D. or + 11 D., so that after operations for cataract a lens approximately of this strength must be worn by the patient to enable him to see distinctly. Inasmuch as there is also an absence of

FIG. 112.

Closure and displacement of pupil from iritis following extraction of cataract. (Nettleship.)

accommodative power an additional lens 3 D. or 4 D. stronger must be employed for near work. There usually results also from the corneal wound a slight amount of astigmatism, which must be taken into consideration in the prescribing of the glasses. The glasses should not be given until the eye has become perfectly quiet, and if there results much astigmatism primarily this will gradually subside after several months.

Congenital or Juvenile Cataract (Soft Cataract). **Complete Congenital Cataract** is frequently met with. When seen it is usually bilateral, and the lens presents a whitish appearance. It is frequently associated with some choroidal disease, and if not operated upon nystagmus oftentimes develops. It is very difficult in young infants

to test the light field and light projection, but some information can be obtained by noting whether the little patient's eyes follow a lighted candle. The condition is sometimes due to heredity.

Treatment. The treatment for complete congenital cataract consists of the operation of discission.

Partial Congenital Cataracts are the zonular or lamellar (Fig. 95), and the pyramidal or polar cataracts (Figs. 96 and 97). The lamellar variety is perhaps the most common form of cataract found in children. With the ophthalmoscope there is observed in the centre of the lens an opacity of various shapes, being frequently hexagonal, which is not only surrounded by clear lens substance, but clear lens is also found within. Vision is reduced according to the density and size of the opacity.

Treatment. If vision is very little affected no treatment is required. If vision improves under mydriatics an optical iridectomy may be performed. If the vision is very poor and cannot be improved under mydriasis by means of glasses, the operation of discission should be performed.

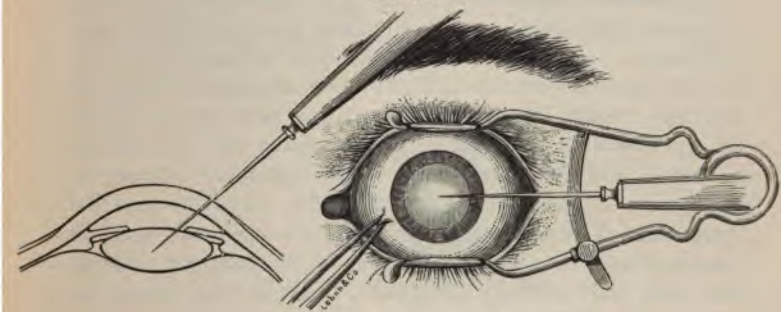
Pyramidal Cataract is found in the shape of a pyramid on the anterior capsule, and consists of thickening of the capsular epithelium. With it is frequently found a central corneal scar, in which case both resulted from a former ulcer of the cornea which perforated. In other cases the condition is inflammatory in nature. As a rule no treatment is required.

Discission of Cataract. This is an operation which is performed in soft cataracts. Cocaine anæsthesia is sufficient except in young infants, where general anæsthesia is required. The instruments necessary are an eye speculum (Fig. 105), a pair of fixation forceps (Fig. 103), and a discission needle, which may be either a lance (Fig. 111) or a knife needle (Fig. 110).

The pupil being widely dilated by previous instillation of atropine and the eye being firmly held with the fixation forceps, the needle is made to enter the anterior

chamber at a point either about the centre of the lower and outer quadrant of the cornea, or in the horizontal meridian midway between the centre of the cornea and its outer border. After entering the anterior chamber the needle is pushed forward to the pupillary border opposite the point of entrance, when, by using the cornea as a fulcrum and elevating the handle of the needle, at the same time slightly withdrawing it, a transverse cut is made in the capsule and superficial lens substance (Fig. 113). A second cut, if required, is made at right angles to the first, after which the needle is withdrawn. Atropine is instilled, both eyes are bandaged, and if there should be

FIG. 113.



Discission of cataract. (Juler.)

any reaction cold compresses are applied. As a rule, several discission operations are required for the complete removal of soft cataracts. It is not wise to make the cut too deeply into the lens substance at the first operation, because a lens may rapidly swell and produce severe inflammatory symptoms. If the condition of secondary glaucoma should come on as the result of the operation it may be necessary to perform an operation known as simple linear extraction.

Simple Linear Extraction of Cataract. The instruments required for this operation are a speculum (Fig. 105), fixation forceps (Fig. 103), a keratome (Fig. 124), and a

spatula (Fig. 106). The eye having been anæsthetized and firmly held by means of the fixation forceps, which seize the conjunctiva on the nasal side of the cornea, the keratome is made to enter the anterior chamber in the outer half of the cornea, the point of entrance usually being midway between the centre and the periphery, the pupil having been previously dilated to its fullest extent. As the keratome is being withdrawn the lower lip of the wound is slightly depressed, and slight pressure made upon the opposite side of the eye by the forceps if necessary, when the swollen lens matter is gradually evacuated. If all of the lens matter does not come out in this procedure subsequent discissions are required.

Traumatic Cataract. This is a condition in which an accidental discission of the lens has practically been performed. There may be an external wound, or it may be that the lens capsule has ruptured, thus permitting the aqueous humor to enter, without any perforating wound of the eyeball. Shortly after the injury the lens begins to swell and becomes more or less opaque. It may be that some of the cortical matter falls into the anterior chamber. The tendency is toward absorption of the soft lens, and as a consequence in some of the younger patients the lens may entirely disappear. As a rule, however, the rent in the capsule closes, and subsequent operation becomes necessary for its removal.

Treatment. The treatment of traumatic cataract consists in the instillation of atropine to prevent iritis, the application of cold compresses, and if the lens becomes so swollen as to produce symptoms of glaucoma, simple linear extraction must be performed. When the eye becomes quiet, showing that further progress in the absorption of the lens has been stopped, the operation of discission may be performed.

Complicated Cataracts. These are the cataracts which are secondary to some pre-existing disease, and are the anterior polar, the posterior polar, and the complete secondary cataract.

The Anterior Polar has been described. (See Pyramidal Cataract, page 248.)

The Posterior Polar Cataract is an opacity in the lens substance near the posterior pole. It is more or less star-shaped, and sometimes resembles the spokes of a wheel (Fig. 97). It may be associated with disease of the interior structures of the eye, for example, choroiditis, hyalitis, and retinitis pigmentosa. It may remain stationary or proceed to the formation of complete cataract.

Treatment. The treatment for complete secondary cataracts is the same as for senile or juvenile cataract, depending upon the age of the patient.

Dislocation of the Crystalline Lens. Dislocation of the crystalline lens may be either partial or complete. The condition is rarely met with as a congenital anomaly.

FIG. 114.

Traumatic dislocation of the lens.

There is marked disturbance of vision and impaired accommodation. Sometimes monocular diplopia is present. If the lens is partially dislocated an examination with the ophthalmoscope will show the edge appearing in the pupil as a dark line against the red background of the fundus. The iris is also tremulous in that part which has lost its support of the suspensory ligament. The lens may be partially dislocated downward so that the edge shows in the pupillary space; it may be entirely within the anterior chamber, or it may be completely turned on its vertical axis so as to divide the anterior chamber and pupil practically into two halves (Fig. 114). If the dislocation is complete it usually lies in the vitreous and becomes opaque.

Diagnosis. The diagnosis may be made by an examination with the ophthalmoscope when there is either an absence of the lens or only the edge appears in the pupillary space against the reddish background. A different lens will be required to see the fundus through the edge of the lens and through the pupillary space beyond the lens.

As a result of dislocation of the lens there may follow iritis, cyclitis, choroiditis, hyalitis, or secondary glaucoma.

Treatment. The treatment depends upon the condition of the eye and the position of the lens. If the latter lies

FIG. 115.

Dislocation of lens. (Jaeger.)

in the anterior chamber it should be removed. If it lies in the vitreous and is producing irritation an attempt at removal by means of the wire loop should be made. If it has been dislocated beneath the conjunctiva it may be removed through a small incision made directly over it. Occasionally partial dislocation produces no symptoms of irritation, when it may be let alone and the patient provided with the best glasses.

Congenital Anomalies. **Coloboma of the Lens** is occasionally found and usually accompanies a similar defect in the iris or choroid, or both. (See Plate VI.) When seen the lens may be deficient either in the form of an

indentation or by a flattening of its edge. The defect is usually situated in the lower portion of the lens.

Lenticonus is that congenital condition of the lens in which there is an abnormal curvature, usually from the posterior surface, or it may be a conical projection from either the anterior or posterior surface. An ophthalmoscopic examination reveals a peculiar reflex resembling a drop of oil on the surface of the lens. Lenticular opacity may, or may not, accompany this condition.

Congenital Cataract and **Congenital Dislocation** of the lens have been described elsewhere.

CHAPTER XIV.

GLAUCOMA.

Glaucoma is a term which has been applied to a series of symptoms the chief of which is an increase of the intraocular tension which results in a hardening of the globe.

Primary Glaucoma is a term employed to describe that variety of glaucoma which arises independently of any pre-existing disease.

Secondary Glaucoma is that variety which results from some pre-existing pathological condition.

Most writers divide primary glaucoma into acute and chronic inflammatory glaucoma, and non-inflammatory, or simple, glaucoma.

Acute Inflammatory Glaucoma. There may or may not be prodromal symptoms preceding an attack of acute inflammatory glaucoma. If prodromal symptoms are present there may be a frequent desire on the part of the patient to change his glasses. This is caused by a change in the accommodation on account of the slight temporary increase of the tension of the eyeball. There may also be temporary attacks of "foggy" vision lasting from a few minutes to a few hours. This may be accompanied by iridescent vision, or the appearance of colored halos around artificial lights. Slight pain and moderate dilatation of the pupil, together with some haziness of the cornea, may be observed if the patient is seen during this stage. This condition may exist for a considerable period of time, when it is suddenly replaced by the glaucomatous attack.

The Glaucomatous Attack is very apt to begin somewhere between midnight and early morning. It may be

that the prodromes have or have not been previously observed. The patient has retired with normal vision and suddenly wakens to find himself suffering the most *excruciating pain* which may be sufficiently severe to produce nausea and vomiting. This pain is not confined to the eyeball, but extends along the supraorbital and infraorbital nerves, and is frequently accompanied by considerable depression. *Vision is markedly reduced,* or almost entirely abolished. The *colored halos* may be present when looking at artificial light. If an examination of the eye is now made the *lids will be found somewhat swollen* and the *conjunctiva will present considerable injection* in the immediate neighborhood of the cornea. The *cornea itself will be more or less hazy* according to the degree of hardness of the eyeball, and will also be partially or wholly *anæsthetic.* This latter symptom may be tested by touching the cornea with a wisp of absorbent cotton and observing that the reflex action of the lids is sluggish or absent. The *aqueous humor will be found turbid,* and the *pupil widely dilated* or *semidilated,* and possessing but little mobility. The *anterior chamber may be more shallow* than normal because of a slight change in the position of the lens. If the *tension of the eyeball* is now tested it will be found to be *increased.* This increase is noted, as described elsewhere, as $T + 1$, $T + 2$, or $T + 3$, the latter representing a stony hardness of the eyeball. Both eyes are usually attacked, but there may be a period of several weeks or months between the two attacks. It is impossible to examine the interior of the eye with the ophthalmoscope during a glaucomatous attack on account of the haziness of the media.

Course of Acute Inflammatory Glaucoma. These symptoms gradually subside with the exception, perhaps, of a moderate limitation of the visual field, a very slight increase of the tension of the eyeball, and a slight impairment in the mobility of the iris. After a short time, however, the attack repeats itself, and after a number of attacks have occurred there may be found considerable

limitation of the visual field, the characteristic cupping of the optic disk surrounded by the glaucomatous halo, and pulsation of the retinal arteries.

If the progress of the disease is not checked it passes ultimately into that condition which is known as *absolute glaucoma,* consisting of stony hardness of the eyeball, a hazy and anæsthetic cornea, shallow anterior chamber, turbid aqueous humor, a dilated and immobile pupil, discoloration of the iris and a greenish reflex from the lens, which may become cataractous. The structures of the entire eyeball may finally become entirely disorganized and be followed by atrophy.

Instead of following the course just described the condition may sometimes pass into *chronic inflammatory glaucoma,* which presents a picture somewhat like that of acute inflammatory glaucoma; the conjunctival veins are enlarged and more or less tortuous, there is a moderate haziness of the cornea, together with some anæsthesia, the pupil is irregularly dilated and very sluggish in its movements, the anterior chamber is shallow, and there is a distinct greenish reflex from the lens. The pain is not so severe as in the acute type. The vision, both peripheral and central, diminishes, and in the late stages distinct cupping of the optic disk can be observed. If unchecked this variety may pass into the condition of absolute glaucoma.

Simple Glaucoma (Non-inflammatory Glaucoma, Chronic Simple Glaucoma). This variety of glaucoma presents itself very insidiously, and is usually first brought to the patient's attention by the discovery of a *partial loss of vision.* It is not accompanied by any pain, nor are there any external symptoms by which the disease may be positively detected. The *tension of the eyeball* is but moderately elevated, and at times it is most difficult to determine whether there is any increase at all. Practically no change can be noted in the anterior chamber, and it is only during the time of increase of the intraocular tension that careful inspection will reveal a very *slight*

haziness of the cornea. There may or may not be present a *desire on the part of the patient to make a frequent change in his glasses,* and he may have noted at times *iridescent vision.* An examination with the ophthalmoscope will reveal clear media and a *characteristic cupping of the optic disk* with the *glaucomatous halo* surrounding it (Fig. 116). This cupping varies in extent according to the progress of the disease. It may be complete, the blood-

FIG. 116.

Ophthalmoscopic appearance of chronic glaucoma. (Jaeger.)

vessels dipping suddenly over its margins and reappearing at the bottom of the cup, or only a portion of the disk may appear to be cupped, the vessels being crowded toward the nasal side. Surrounding the optic disk is a yellowish ring of choroidal atrophy which is known as the glaucomatous halo. *Pulsation of the retinal arteries* may be present, and if not present may be readily produced by slight pressure upon the eyeball.

If the *field of vision* is now taken it presents changes which are more or less characteristic. It may be concentrically contracted or may assume various odd shapes. A quadrant of the field may be missing, the blind area extending to the neighborhood of the fixation point. The whole field may be lost with the exception of a small area on the temporal side. The various kinds of scotomata may be observed. The color fields are usually contracted proportionately to the form fields. A variety of contraction which is frequently met with is that in which the whole field is concentrically contracted, the contraction being more marked on the nasal side.

FIG. 117.

Section of optic nerve head showing glaucomatous cup. (Jaeger.)

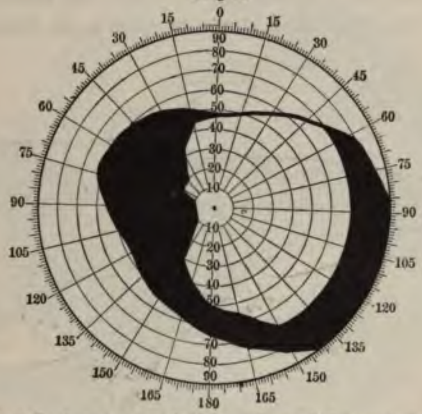
Course of Simple Glaucoma. Simple glaucoma may assume symptoms of an inflammatory nature, but more frequently progresses to absolute blindness without any such condition. One eye only may be affected when the patient first comes under observation, but in the vast majority of cases, sooner or later, both eyes become involved.

Causes of Glaucoma. Age is one of the predisposing causes, primary glaucoma being rarely met with before the fortieth year. It is very frequently observed in Hebrews and the Eastern races. A rheumatic or gouty diathesis may be present and exert some causative influence. The refraction of the eye is usually hypermetropic, it being

unusual to meet with glaucoma in myopia. The exciting causes, in addition to the gouty and rheumatic diathesis

Fig. 118.

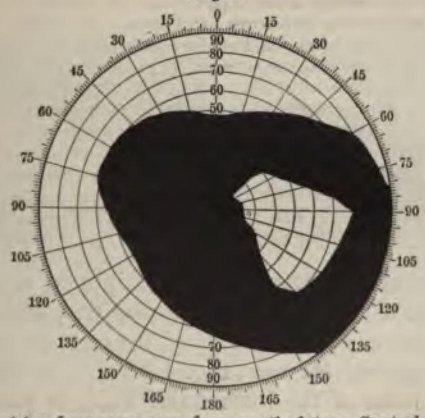
Right



Field of vision from a case of advanced non-inflammatory glaucoma. Central vision normal. Operation declined.

Fig. 119.

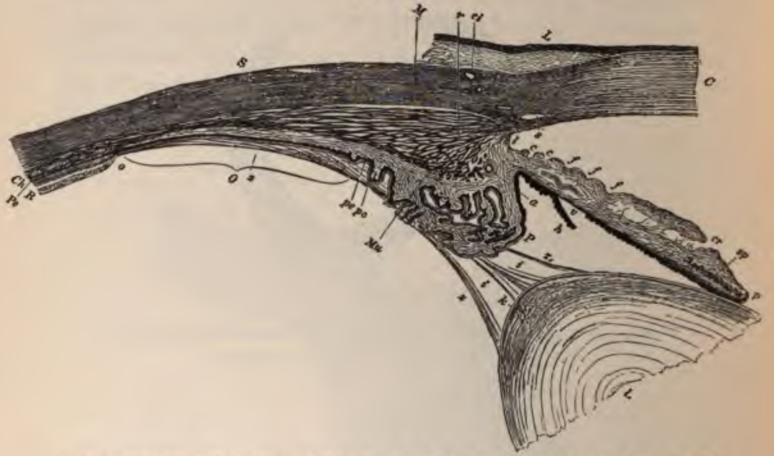
Right



Field of vision from same case, four months later. Central vision lost.

above referred to, are worry, insomnia, arterial disease, and trifacial neuralgia. Glaucomatous attacks have followed the instillation of a mydriatic; it is therefore wise to employ such drugs with especial caution after the fortieth year when the lens has become more or less sclerosed. The disease is somewhat more frequent in females than in males.

FIG. 120.



Meridianal section through anterior part of the eye, showing the ciliary body and iris, with neighboring structures. *C.* Cornea. *S.* Sclera. *s.* Schlemm's canal. *L.* Limbus conjunctivæ. *ci.* Anterior ciliary vein. *l.* Ligamentum pectinatum. *cr.* Crypts in circulus minor iridis. *c.* Periphery of iris. *f.* Contraction furrow. *hvp.* Retinal pigment of iris. *v.* Anterior layer of retinal pigment. *p.* Pupillary margin. *sp.* Cross-section of sphincter pupillæ. *M.* Longitudinal fibres of ciliary muscle, Brücke's portion. *Mu.* Circular fibres or Müller's portion. *r.* Transition of radial fibres. *a.* Circulus arteriosis iridis major. *P.* Ciliary processes. *pe.* Pigment cellular layer. *Pe.* Pigment epithelium. *pc.* Non-pigmented layer. *R.* Retina. *O.* Orbicularis ciliaris. *o.* Ora serrata. *ch.* Choroid. *z.* Fibres of zonule of Zinn. z_1. Free portion of zonula. *i.* Canal of Petit. *L.* Lens. *k.* Nuclei of lens. Magnified 14 times. (After Fuchs.)

Mechanism of Glaucoma. The periphery of the anterior chamber formed by the cornea, iris, and pectinate ligament is known as *the angle of the anterior chamber or filtration angle of the eye* (Fig. 120). The direction of the flow of most of the intraocular fluid, in passing from

the eye, is from the posterior chamber into the anterior chamber, and thence through the angle of the anterior

FIG. 121.

The angle of the anterior chamber in a healthy eye, showing the canal of Schlemm, the ligamentum pectinatum, and lymphatic crypts at the periphery of the iris. (Treacher Collins.)

FIG. 122.

The angle of the anterior chamber in a case of primary glaucoma, showing closure of the filtration area at the periphery of the cornea, by apposition with it of the root of the iris. (Treacher Collins.)

chamber, by way of Fontana's spaces and the canal of Schlemm, into the anterior ciliary veins. Probably in every case of glaucoma the disease originates by interference with the escape of the intraocular fluids through the angle of the anterior chamber of the eye. (Compare Figs. 121 and 122.) This may be brought about by the pressing forward of the root of the iris by an enlarged lens, or by sudden pressure upon the lens from the vitreous chamber. Priestley Smith is of the opinion that the enlarged flattened lens which is present in hyperopia, or in advancing years, is chiefly instrumental in the production of primary glaucoma by pressure against the root of the iris blocking the lymph spaces at the filtration angle.

Diagnosis of Glaucoma. It is of the greatest importance that the diagnosis of glaucoma be established as early as possible, so that proper treatment may be administered. The prodromal symptoms, consisting of the frequent desire to change the reading glasses, temporary periods of "foggy" vision, and the appearance of a halo, or rainbow colors, around artificial lights, should put one on the lookout for an attack of glaucoma.

The most frequent diseases for which acute inflammatory glaucoma is mistaken are acute catarrhal conjunctivitis and acute iritis. There are a number of points of difference between the symptoms of these diseases, but the condition of the pupil, the cornea, and the tension of the eyeball in each are those that are most important. In acute inflammatory glaucoma the pupil is dilated and more or less immobile; the cornea is hazy and partially or wholly anæsthetic; and the intraocular tension is increased. In acute iritis the pupil is contracted and attached by posterior synechiæ to the anterior capsule of the lens; the cornea is not anæsthetic and is not markedly hazy, except in the serous variety, when the haziness is due largely to the deposits on the posterior surface of the cornea, and is triangular in shape; and the tension is not altered. In acute catarrhal conjunctivitis the pupil, the

cornea, and the tension are not changed from normal. The following table will asist in the diagnosis:

Acute Inflammatory Glaucoma.	Acute Catarrhal Conjunctivitis.	Acute Iritis.
1. Conjunctival injection most marked near the cornea.	1. Conjunctival injection least marked near the cornea.	1. Conjunctival injection most marked near the cornea.
2. Cornea very hazy in all portions, and anæsthetic.	2. Cornea clear.	2. Cornea more or less hazy; markedly so in serous iritis with triangular arrangement of dots on the posterior surface.
3. Pupil dilated, or semi-dilated, and more or less immobile.	3. Pupil normal.	3. Pupil contracted with posterior synechiæ.
4. Iris pushed forward, especially in the periphery; irregularities of surface.	4. Iris unaffected.	4. Iris discolored; surface irregular.
5. Aqueous humor frequently turbid.	5. Aqueous humor unaffected.	5. Aqueous humor frequently turbid.
6. Anterior chamber shallow.	6. No change in anterior chamber.	6. But little change in anterior chamber, except in serous variety when it is deeper than normal.
7. Conjunctiva usually transparent.	7. Conjunctiva opaque.	7. Conjunctiva usually transparent.
8. As a rule, great tenderness upon pressure.	8. Tenderness not marked.	8. Some tenderness upon pressure.
9. Severe pain following the distribution of the trigeminal nerve, as well as in the eye itself.	9. Very little pain, and if present referred to the eye itself.	9. Severe pain, worse at night, referred to the brow or temple.
10. Marked dimness of vision.	10. Vision not affected.	10. More or less dimness of vision.
11. Tension increased.	11. Tension normal.	11. Tension normal.

The differential diagnosis between simple glaucoma and optic nerve atrophy is much more difficult. If it can be definitely determined that the intraocular tension is increased it will materially assist in differentiating the two diseases. In simple glaucoma the color fields are, as a rule, contracted proportionately to the form fields, whereas in optic nerve atrophy the color fields present a much

more marked contraction than do the fields for form. Occasionally cases are seen in which the failing vision of simple glaucoma has been mistaken for that of cataract, on account of the greenish reflex from the lens. This mistake, however, can never be made if an examination of the eye is made with the ophthalmoscope.

Prognosis of Glaucoma. If glaucoma is unchecked it leads ultimately to absolute blindness. The most favorable prognosis is found in the acute inflammatory type. The prognosis is not so good in simple glaucoma, and depends upon the condition of both central and peripheral vision. In simple glaucoma it is rare to make any improvement of the central or peripheral vision present at the time the patient places himself under treatment. The prognosis depends upon whether the treatment succeeds in preventing further contraction of the visual field.

Treatment of Glaucoma. The best and most satisfactory *treatment for acute inflammatory glaucoma* is some operative procedure, preferably an iridectomy; but if for any reason an operation cannot be at once performed, certain medicinal treatment may be temporarily employed. As the iris is crowded into the periphery of the anterior chamber, blocking up the filtration angle of the eye, an attempt should be made to withdraw it by means of myotics which contract the pupil. A solution of eserine (gr. $\frac{1}{2}$ to ij–℥j), or a solution of pilocarpine, double this strength, should be employed. In the prodromal stage the instillation of a drop or two into the conjunctival sac of the eye affected, four or five times a day, is usually sufficient to relieve the symptoms temporarily. In the treatment of the actual attack, however, it is necessary to employ it much more frequently. A drop or two of the solution of eserine, or pilocarpine, should be instilled into the conjunctival cul-de-sac of the glaucomatous eye every half hour or hour until the pupil becomes contracted and the tension is relieved, provided this action is obtained, and then continued at less frequent intervals. The action of the myotic may be increased by preceding each instillation

by the instillation of a drop of a 4 per cent. solution of cocaine. If, however, the myotic solutions do not produce contraction of the pupil with reduction of the intraocular tension, it is necessary, for the safety of the eye, to undertake the operative treatment at once.

In the *treatment of an attack of acute inflammatory glaucoma* it is necessary to employ any form of therapeutics which will assist the action of the myotics in temporarily relieving the condition. A few leeches to the temple, and the frequent application of hot fomentations to the eye, will materially assist in the relief of the pain and in the promotion of the action of the myotics. Rest in bed, preceded by a warm bath and the administration of a purgative, is also of service. If the pain is very severe a hypodermic injection of morphine will not only serve to relieve it, but will assist in the contraction of the pupil. Large doses of salicylate of sodium have been advocated by some authors, and are of great service, especially if the disease is accompanied by marked pain, or associated with rheumatism. Under any circumstances medicinal treatment is only temporary. It must be followed sooner or later by operative procedure if a cure is to be expected.

The operation which seems to be preferred by the greatest number of ophthalmic surgeons is a *broad peripheral iridectomy*. An *anterior sclerotomy*, a *posterior sclerotomy*, or *excision of the superior cervical sympathetic ganglion* may be performed under certain circumstances in place of an iridectomy.

The *treatment of chronic inflammatory glaucoma* requires the use of the myotics in much weaker solutions unless there should be subacute attacks. Eserine in the strength of $\frac{1}{16}$ to $\frac{1}{6}$ of a grain to the ounce, of which solution a drop or two is instilled two to four times a day, is usually sufficiently strong. If pilocarpine is employed the strength should be double that of the eserine solution. The internal administration of such drugs as have proved of benefit in optic nerve atrophy are also to

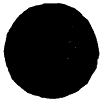
be employed. For this purpose full doses of strychnine and nitroglycerine have been used with considerable benefit. The result of an iridectomy in chronic inflammatory and in simple glaucoma has not been so successful as in the acute inflammatory type. There is a large percentage of cases in which the disease is permanently checked, but on the contrary there is also a large percentage of cases in which the disease is not checked. In a few the operation seems to have given greater progress to the affection. All things being considered, an operation for these types of glaucoma should be performed *before there has been much contraction of the visual field.* If, therefore, the employment of the myotics, together with the use of strychnine and nitroglycerine, fails to check the gradual contraction of the field of vision, an iridectomy should be performed. If, on the other hand, the remedies just referred to seem to hold the disease in check, it is perhaps wise not to perform an iridectomy until they have lost their effect. In chronic inflammatory glaucoma in which degeneration of the iris has not taken place it naturally follows that an iridectomy will be of more benefit in checking the disease than if such degeneration has occurred. In simple glaucoma an iridectomy does not do more than hold the vision where it is at the time of the performance of the operation, and if one waits until the field of vision is contracted to the immediate neighborhood of the fixation point, further contraction of the field is likely to follow operative procedure. In those cases in which one eye has become blind from glaucoma and the second eye is attacked, it is well to follow Schweigger's advice and operate upon the blind eye first. If this heals successfully and without complication it may be naturally presumed that a similar result will follow operation upon the other eye.

In a very few cases a perfectly performed iridectomy is sometimes followed by marked increase in tension, a blocking up of the anterior chamber, considerable ciliary tenderness, with œdema of the lids, and rapid loss of the

vision—a condition known as *malignant glaucoma.* The symptoms usually present themselves a day or two after the iridectomy has been performed. The *treatment of malignant glaucoma* consists in the frequent instillation of a myotic, the administration of large doses of salicylate of sodium, posterior sclerotomy, together with slight pressure upon the cornea through the closed lids to endeavor to push the lens back in place, and thereby restore the anterior chamber.

In *the treatment of all varieties of glaucoma* it is important to avoid worry, excessive use of the eyes, work in improper light or with uncorrected refractive error, insomnia, irregular meals, or any condition which might bring about an attack. If a gouty or rheumatic diathesis is present the employment of warm baths, and of such

FIG. 123.



Iridectomy for glaucoma. (De Wecker.)

waters and drugs as will eliminate the poison from the system, is called for. Massage of the eyeball and the employment of galvanism have been recommended, but cannot take the place of the myotic and operative treatment.

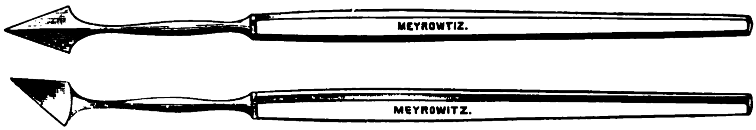
In *absolute glaucoma,* in which the eye is exceedingly painful, it is sometimes necessary to perform enucleation if an iridectomy fails to relieve the pain.

Iridectomy for Glaucoma. As previously stated, an iridectomy for glaucoma must be broad and peripheral. It should include a segment equivalent to about one-fifth of the circumference of the iris, which should be removed as close to its ciliary border as possible (Fig. 123). This is effected by making the corneal section somewhat posterior to the corneo-scleral junction, the keratome being

entered about one and one-half millimetres back of the limbus (Fig. 131). At the time of the withdrawal of the iris by the iris forceps, instead of excising it with one cut of the iris scissors, it is better to excise one side, and then, drawing the iris as far toward the opposite side of the section as possible, the remaining portion is cut.

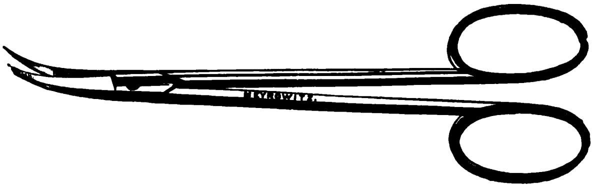
Operation of Iridectomy. Local anæsthesia is employed except in cases of severe inflammation in children, and very nervous patients. The instruments required are a speculum (Fig. 129), keratome (Fig. 124), fixation forceps (Fig. 103), iris forceps (Fig. 127), iris scissors (Figs. 125 and 126), spatula (Fig. 106), and in some cases a blunt iris hook (Fig. 128). A few surgeons employ a Graefe cataract knife (Fig. 99) with which to make the corneal opening, rather than a keratome.

FIG. 124.



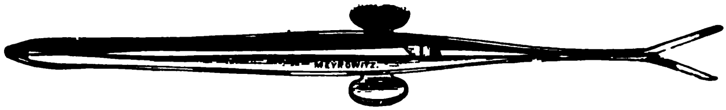
Keratomes.

FIG. 125.



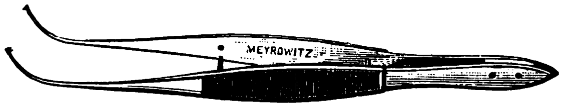
Curved iris scissors.

FIG. 126.



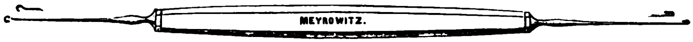
De Wecker's iris scissors.

Fig. 127.



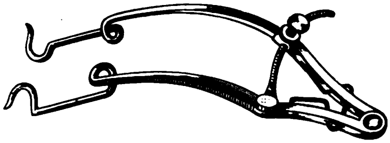
Iris forceps.

Fig. 128.



Tyrrell's sharp and blunt hook.

Fig. 129.



Eye speculum.

1. The speculum having been introduced, the eye is grasped with the fixation forceps opposite to the point of entrance of the keratome or that portion of the iris to be excised. The keratome is entered at the corneo-scleral junction parallel to the plane of the iris (the point of entrance in glaucoma being 1 to 2 mm. behind the corneo-scleral junction), and passed into the anterior chamber sufficiently far to permit the removal of as wide a piece of the iris as is desired. In entering the knife, care is exercised to avoid injury to the cornea or lens, and it is withdrawn very slowly to allow the gradual escape of the aqueous humor. If the latter escapes too quickly the sudden lowering of the ocular tension may be followed by severe intraocular hemorrhage.

2. If the iris presents itself in the wound it is seized with the iris forceps, slightly withdrawn, and excised with one or two snips of the scissors. Should the iris fail to present at the wound with the escape of the aqueous, the

iris forceps, closed, are passed into the anterior chamber almost to the pupillary margin, the iris seized, withdrawn, and excised.

FIG. 130.

Position of operator's hands in first stage of iridectomy. (Czermak.)

If there is much bleeding from the cut surface of the iris, the blood collecting in the anterior chamber, an attempt at removal may be made by gentle pressure upon the

cornea with a spatula or by means of the lower lid, the finger being placed outside. Only the gentlest manœuvres should be made, however, as bruising of the lens will produce traumatic cataract, and the blood is usually absorbed.

FIG. 131.

Iridectomy. *a.* Peripheral incision, as in glaucoma. *b.* Wide iridectomy. *c.* Narrow or optical iridectomy. (Czermak.)

3. A spatula is now passed between the lips of the wound to approximate the edges, to remove any débris, and to replace the angles of the coloboma in their proper positions in the anterior chamber. Both eyes are bandaged for forty-eight hours, after which the bandage may be

FIG. 132.

Iridectomy downward and inward for artificial pupil. (Nettleship.)

removed and a shade and dark glasses substituted. At the first dressing, a drop of a sterile solution of atropine should be instilled to draw the cut edges of the iris away from the lens capsule; otherwise a few adhesions between the two are apt to occur.

Anterior Sclerotomy is sometimes performed in place of an iridectomy in those cases in which an iridectomy has failed to check the progress of the disease. By a

few surgeons it is performed in all cases in preference to iridectomy. The method is as follows: The eyelids are separated by means of an eye speculum, the eyeball being fixed with the fixation forceps. The point of a Graefe cataract knife is passed into the anterior chamber at a point 3 mm. below a tangent to the uppermost part of the cornea and 1 mm. behind the apparent corneo-scleral junction, then across the anterior chamber, and the puncture made at a point diametrically opposite. An upward cutting movement of the knife, as in the section for the extraction of cataract, is now made, but instead of completing the section and making a corneal flap, a bridge of tissue, about 3 mm. broad at the uppermost part of the cornea, is left undivided. The knife is now tilted slightly forward, causing the lips of the wound to gape somewhat, allowing the aqueous humor to escape, if it has not already done so, and then slowly and cautiously withdrawn. The bridge of tissue is left to guard against prolapse of the iris; but if this accident should occur, as it does sometimes, the iris must be replaced into the anterior chamber by means of a small spatula. Should this not prove effectual, the prolapsed portion must be cut off with scissors, thus converting the sclerotomy into an iridectomy.

Posterior Sclerotomy (Scleral Puncture) is sometimes performed as a preliminary to iridectomy in acute inflammatory glaucoma, and is sometimes employed for temporary relief without being followed by an iridectomy. The same instruments are employed as in anterior sclerotomy, and the knife is passed through the posterior scleral tissue with its cutting edge toward the cornea, as this is the direction of most of the scleral fibres. The point of selection is, as a rule, midway between the external and inferior recti muscles, several millimetres posterior to the ciliary bodies. The knife may be passed directly through the conjunctiva and sclera to a depth of 2 or 3 millimetres, and then rotated through a quadrant of a circle and withdrawn; or an opening may be made

in the conjunctiva, and the latter moved so as to place the scleral opening in a different position. It does not matter which method is followed, as the wound usually heals without difficulty.

This same operation is sometimes performed for detached retina.

Excision of the Superior Cervical Sympathetic Ganglion. This operation for glaucoma was suggested by Abadie, because he believed the disease was produced by some excitation of the vasodilator fibres of the ocular bloodvessels. It has been performed many times, but the concensus of opinion seems to be that if employed at all it should be only in those cases in which iridectomy appears inadvisable, such as cases of hemorrhagic glaucoma or cases of advanced glaucoma with greatly reduced vision. In many of the reported cases, central and peripheral vision have temporarily improved only to be rapidly lost.

Secondary Glaucoma is a term which is applied to all cases in which there has been an increase of the intra-ocular tension of the eyeball which has been brought about by some preceding disease of the eye. Under this heading we have the glaucoma which is due to intra-ocular growths, the glaucoma which is produced by the closure of the pupil and the filtration angle of the anterior chamber in iritis and cyclitis, the glaucoma produced by traumatism, and hemorrhagic glaucoma.

In **Hemorrhagic Glaucoma** there are numerous hemorrhages from the retinal bloodvessels which are caused by disease of the walls of the vessels. Hemorrhagic glaucoma may follow retinal hemorrhages occurring in the various types of retinitis.

Symptoms. The symptoms are similar to those which have been described in acute inflammatory glaucoma, but may be masked by the conditions giving rise to the disease. It is sometimes most difficult to decide whether the glaucoma is produced by the hemorrhages or the hemorrhages by the glaucoma.

Prognosis. The prognosis is very bad. In most cases it is inadvisable to perform an iridectomy because of the severe hemorrhage which usually follows.

Treatment. The instillation of eserine or pilocarpine, together with the use of such drugs as will help the vascular conditions of the eye, are the remedies which seem to be of most use. Sclerotomy has been advised in this condition, but, unfortunately, operative procedure usually results in marked increase of the hemorrhages. In most cases vision may ultimately be entirely destroyed, so that enucleation becomes necessary for the relief of the pain.

Buphthalmos (Congenital Glaucoma, Congenital Hydrophthalmos, Keratoglobus). This is a variety of glaucoma met with in childhood depending upon the failure of the filtration angle of the eye to open during fœtal life, as it does normally. There is a consequent increased intraocular tension which ultimately leads to a decided increase of all of the diameters of the eyeball, causing it to appear much larger and more prominent than normal. *Keratoglobus* is a name which has been sometimes employed when the cornea has become larger than normal. The ophthalmoscope shows the lens to be small and the optic disk to be cupped in appearance. The prognosis is bad, and if the use of myotics does not check the progress of the disease an iridectomy or sclerotomy should be performed.

CHAPTER XV.

DISEASES OF THE ORBIT.

General Symptoms of Orbital Disease. There are certain symptoms which are usually present to a greater or lesser degree in most affections of the orbit. *Proptosis*, or *exophthalmos*, is that condition in which the eyeball is pushed from its position in the orbital cavity. It may be produced by inflammations, by tumors, by disease of the adjoining cavities, by exophthalmic goitre, and to a certain extent by paralysis of the external ocular muscles. It is the opposite of *enophthalmos*, or that condition in which the eyeball seems to sink deeply into the orbital cavity, which may result from traumatism or appear as an idiopathic affection. *Immobility of the eyeball*, either complete or partial, is sometimes found in connection with orbital disease. There may also be observed at times some *œdema of the conjunctiva*, some *œdema* and *redness of the eyelids*, more or less *pain* and *disturbance of vision*.

Fluctuation can sometimes be detected if an abscess is present.

Orbital Cellulitis (Orbital Abscess). This is an acute inflammatory condition of the tissues of the orbit which depends upon infection.

Symptoms. The patient complains of a deep-seated, intense pain, which is usually increased by pressure upon the eyeball. The eyelids are more or less swollen and red. The ocular conjunctiva is sometimes so œdematous as to hide almost the entire cornea. In marked cases it protrudes from between the lids so that the latter cannot be closed. There is proptosis, the eyeball being pushed directly forward, together with limitation of the ocular

movements in all directions. Vision is greatly impaired, and in some cases is entirely lost. The ophthalmoscopic examination usually reveals an optic neuritis, with extensive retinal hemorrhages, due to pressure upon the optic nerve which may result in subsequent atrophy. If the pressure upon the cornea lasts for some time the latter is likely to slough. These various symptoms may begin with a severe chill, followed by fever and general malaise.

Course. The course of the affection is usually rapid, and it may terminate in resolution or in the formation of an abscess which may rupture externally on some portion of the upper lid near the orbital margin, or it may extend posteriorly to the brain, producing meningitis. The condition may result in panophthalmitis.

Causes. Anything which will produce infection of the orbital cavity may give rise to orbital cellulitis, such as foreign bodies in the orbit, or operation wounds; extension of inflammation from adjoining parts, as from erysipelas; or the condition may arise by metastasis, as in pyæmia, etc.

Diagnosis. The differentiation from panophthalmitis is made by an ophthalmoscopic examination and the observation of the clear media; from thrombosis of the cavernous sinus by the absence of cerebral symptoms, by the proptosis and immobility of the eyeball before the occurrence of paralysis of the external muscles, and by the absence of the general venous conditions which enter into thrombosis of this sinus. In purulent conjunctivitis there is much more discharge and no limitation of the ocular movements.

Treatment. Hot fomentations should be applied as soon as the diagnosis has been made, together with the earliest possible evacuation of the pus. This may be done either through the lid, or through the conjunctiva, with a small cataract knife, which must be passed deep into the orbital tissues close to the orbital wall, avoiding the eyeball and the ocular muscles. Should the pus be

evacuated immediate relief will be obtained, and, though pus is not found when the incisions are first made, the free bleeding will be of much benefit. The local condition must be treated by antiseptic measures, and the general condition by means of the administration of quinine, strychnine, milk punches, and nourishing food.

Tenonitis is a somewhat rare condition consisting of inflammation of Tenon's capsule, and is characterized by considerable swelling of the upper lid, some proptosis and limitation of the ocular movements, together with pain upon the least movement of the eyeball. There may be general or local chemosis of the bulbar conjunctiva. The condition may be idiopathic in origin, or result from injury, for example, from a tenotomy ; occasionally it is due to rheumatism.

Treatment. The treatment consists of hot or cold applications, together with the internal administration of large doses of salicylate of sodium or of iodide of potassium.

Periostitis. This condition may be either acute or chronic, and localized or general In **acute local periostitis** there are pain and tenderness over the location of the disease, which is very frequently in the neighborhood of the orbital margin. There may be slight œdema of the conjunctiva, together with swelling of the lids and proptosis. When the affection is general rather than local there are found the usual symptoms of orbital cellulitis to which it gives rise.

Chronic Periostitis is usually accompanied by deep-seated pain, tenderness of the eyeball upon pressure, and there may be some œdema of the lids and conjunctiva. A thickening of the periosteum may sometimes be felt beneath the orbital margin.

Causes. The causes are syphilis, tuberculosis, injury, and disease of the adjoining cavities.

Prognosis. The prognosis depends upon the variety of periostitis with which we have to deal. It is favorable if the affection is local, and is serious if the affection is general, as it may result in paralysis of the external

ocular muscles, optic nerve atrophy, or necrosis of the bones. It may even extend to the brain and produce meningitis and death. Those varieties which have been produced by syphilis are the most amenable to treatment.

Treatment. Should syphilis be found as a cause of the disease the administration of mercury and large doses of iodide of potassium is demanded. In other cases cod-liver oil, iodide of iron, arsenic, and the various tonic prepara-

FIG. 133.

Exophthalmic goitre. (Burr.)

tions should be employed. If an abscess forms the pus should be evacuated as early as possible, and drained by means of a tube or iodoform gauze. If the affection is found to be localized and necrosis results the bone may be curetted and free drainage established.

Exophthalmic Goitre (Graves' Disease, Basedow's Disease). In this condition there are a number of ocular symptoms which make the affection of more or less importance to the ophthalmic surgeon.

The exophthalmos which is present may become so marked that it is impossible for the eyelids to cover the eyeball entirely, the condition resulting in ulceration of the exposed portion of the cornea. There are also certain ocular signs which have been described by different observers as being more or less constantly present in this condition. *Dalrymple's sign* is that the eyelids are more widely separated than normal; *Stellwag's sign* is that the lids are not completely closed in the act of winking, and also that the interval between the attempts at winking is much longer than normal; *von Graefe's sign* is that the upper lid fails to follow the eyeball in its downward movement as completely as it does in the normal eye.

Treatment. The treatment consists, in addition to the treatment for the disease in general, in the protection of the cornea, if the exophthalmos should become excessive, by means of frequent irrigations with a lotion of boric acid, or by a narrowing of the palpebral fissure. If the exophthalmos should become so marked that the cornea completely sloughs it may be necessary to perform enucleation.

Pulsating Exophthalmos is that condition in which there is marked proptosis of the eyeball accompanied by pulsation. The patient may complain of noises in the head and some dizziness; but, as a rule, there is no pain. The pulsation may be increased by leaning the head forward, and the proptosis may be diminished to a certain extent by gently and gradually pushing the eyeball backward into the orbital cavity. A *bruit* may be heard over the eye and over the skull in the immediate neighborhood, and is sometimes diminished by pressure upon the carotid artery. There may be some dimness of vision, together with slight optic neuritis, or marked engorgement of the retinal veins, as well as engorgement of the veins of the lids and conjunctiva.

The condition is most frequently caused by an arteriovenous aneurism produced by rupture of the carotid artery into the cavernous sinus. This condition may in

turn be due to traumatism which has caused a fracture at the base of the skull. A similar condition has been observed to occur spontaneously. A few cases are said to be due to aneurism of the ophthalmic artery.

Course. The course is prolonged, lasting for several months or years, when spontaneous recovery may occur, or death may result from rupture of the aneurism.

Treatment. The treatment consists in compression of the carotid, and if this does not prove of avail ligation of the vessel should be performed.

Tumors and Cysts of the Orbit. **Dermoid Cysts** are occasionally found in the orbital cavity, and are most frequently situated in the neighborhood of the outer upper portion. They are usually congenital, of slow growth, ovoid in shape, and freely mobile beneath the skin, but usually connected with the deeper structures. If the cyst is superficial in character, pressure alters it but little; if there are deeper connections, however, it may be made to disappear within the orbital cavity under pressure. The contents of the cyst are made up of sebaceous material in which there are numerous small hairs.

Treatment. The treatment consists of complete excision. If a portion of the sac remains the cyst is likely to recur.

A Meningocele is a rare congenital condition which usually appears as a fluctuating tumor at the inner angle of the orbit. It may pulsate and may be reduced by pressure on account of its contents being emptied into the cranial cavity. No operative procedure should be undertaken.

The presence of tumors within the orbital cavity will produce certain symptoms depending upon their size, position, and character. There is usually some *proptosis*, the direction of the protrusion of the eyeball depending upon the situation of the growth. If the growth is in the muscle cone the eyeball is usually pushed directly forward; if to the outside of the muscle cone it is pushed

in the direction opposite to the side upon which the tumor is located. There may be *optic neuritis* on account of pressure upon the optic nerve. This may even result at a later date in *optic atrophy*. If large, the tumors can sometimes be felt by the finger tips pressed deeply into the orbital cavity. Malignant tumors grow very rapidly, and benign tumors very slowly. The principal *benign* tumors are *angioma* and *osteoma*, and the *malignant* tumors are *sarcoma* and *carcinoma*. If the benign tumors are increasing in size and producing ocular symptoms they should be extirpated, if possible. Carcinomata

FIG. 134.

Sarcoma of antrum with extension to orbit, producing marked exophthalmos.

should also be extirpated early. There seems to be some doubt as to whether extirpation is of much avail in the case of sarcoma, as the affection usually recurs, and in recurring grows more rapidly than if it had been let alone. If it is possible to remove the whole of the growth by exenteration of the orbital contents, this should be performed. In cases of inoperable sarcoma the use of Coley's mixture may be tried.

Disease of the Adjoining Cavities. So many cavities of the skull lie near the orbit that disease affecting them frequently breaks through into the latter. Thus, we have

the frontal sinus, the maxillary antrum, the ethmoidal cells, and the sphenoidal sinus all connected with the nasal cavities. As a result of inflammation in the nose these cavities may become affected with an inflammatory process, which may be either catarrhal or purulent in character, so producing distention that the orbit will be pressed upon, and, as a consequence, the eyeball will become more or less displaced. *Empyema of the frontal sinus* is perhaps the most frequent, and the transillumination test by means of a small electric light placed below the brow and at the inner angle of the orbit, in a darkened room, will assist in the diagnosis. If the cavity is normal the reflection of the light will be distinctly observed; if filled with pus, the light will not be transmitted and the sinus will appear as a large, dark spot. The condition may be relieved by opening the sinus at the inner angle of the orbit, free drainage, and repeated irrigations with an antiseptic solution. *Empyema of the ethmoid*, if affecting the orbit, may be relieved by making an opening from the inner angle of the eye and effecting free drainage into the nasal cavity. In *empyema of the maxillary antrum* opening into the orbit, free drainage through the nose or through the canine fossa must be obtained.

Congenital Anomalies. **Anophthalmos** is that condition in which there is congenital absence of both eyes. It is an exceedingly rare condition, and according to some authors there is doubt as to whether true anophthalmos exists, as in most cases a post-mortem examination has revealed the eye in a very rudimentary state existing as a small mass in the posterior portion of the orbital cavity. **Monophthalmos** is a term which is employed to describe the congenital absence of one eye. **Cyclopia** is that congenital condition in which there is a fusion of both orbital cavities and their contents, resulting in a single eyeball which is situated in the median line just above the usual position for the arch of the nose. **Microphthalmos** is that condition in which the eyeball at birth is much smaller than normal. **Megaloph-**

thalmos is that condition in which the eye at birth is larger than normal. Both of these conditions are in all probability due to some inflammatory process during intra-uterine life rather than to any arrest of development.

Exenteration (Evisceration) of the Orbit. In cases demanding complete extirpation of the orbital contents, enucleation of the eyeball is performed first in the usual manner, followed by division of the outer angle of the lids as far as the bone. If it is desired to remove the tissue of the lids it is now dissected down to the orbital margin. The periosteum is next divided all around and separated from the bone to the apex of the orbit, the whole mass being excised with a strong pair of curved scissors. Hot water and pressure will usually control the hemorrhage, but in some cases the actual cautery will have to be employed. The lids are sutured together, except a small opening at the inner angle, and the cavity packed with iodoform gauze. The dressings are changed daily or every other day, and the cavity irrigated with boric acid or normal salt solutions until healing has occurred.

CHAPTER XVI.

INJURIES OF THE EYEBALL AND SURROUNDING PARTS.

Injuries of the Lids. Wounds of the lids are to be treated in a manner similar to wounds elsewhere. They should be first cleansed with soap and water to remove all dirt and débris, and then freely irrigated with a solution of bichloride of mercury to make them aseptic. The edges are made smooth and approximated with a few sutures in the best manner for leaving as little distortion as possible. Care must be taken not to turn the cilia toward the eyeball.

Ecchymosis and Swelling of the Lids is very likely to follow an injury. If the case is seen early and before there has been much bleeding beneath the tissues, or before much swelling has occurred, it is sometimes possible to prevent largely these symptoms by painting the parts with a solution of ethereal collodion. If the ecchymosis and swelling are already present, the application of cold compresses, or the application of compresses wrung out in a solution of lead-water and laudanum are usually sufficient.

Emphysema of the lids is sometimes observed, and is a symptom of fracture of one of the orbital bones by means of which there is a communication with one of the accessory sinuses of the nose. There appears a swelling which increases as the patient blows his nose, as the air is forced into the sinus and thus into the tissues.

Burns of the lids usually result from contact with acids, alkalies, hot water, molten metal, or from the explosion of powder. Whatever substance has produced the burn should be thoroughly removed, and the pain relieved by employment of a solution of carbonate of soda, followed

by an application of purified petrolatum to the raw surface. After a powder burn each particle of powder should be removed by means of a fine needle, assisted by the application of peroxide of hydrogen. Jackson has suggested their removal by touching each point with a fine electro-cautery needle.

FIG. 135.

Extensive burn from falling in fire during convulsion. Loss of both eyelids on right side, with some ectropion on left. Vision in right eye destroyed.

Injuries of the Conjunctiva. One of the most frequent injuries to the conjunctiva is the lodgement of a

foreign body upon its surface. The most frequent point of location is beneath the upper lid and in the groove near the ciliary margin. The lids should be everted and the foreign body removed by means of some sterile absorbent cotton wrapped around the end of a probe or stick. The conjunctiva should afterward be irrigated with a solution of boric acid.

Wounds of the conjunctiva are treated as wounds of the lids.

Burns of the conjunctiva are to be treated more for their sequelæ than for the effect at the time of the injury. They occur from acids, alkalies, or molten metal, and as

FIG. 136.

Burns of conjunctiva. (White-Cooper.)

soon as seen should be freely irrigated to remove any particles that are present. Burns from acids or alkalies may be neutralized by means of solutions of carbonate of sodium and vinegar respectively, if these agents are at hand. Thorough and forcible flushing is required for the removal of particles of lime. After the conjunctiva has been thoroughly cleansed the instillation of sterile olive oil, or the application of purified petrolatum, and the passage of a probe once a day to break down any adhesions that may have formed between the conjunctiva of the eyelid and that of the eyeball is the subsequent treatment.

Injuries of the Cornea. **Foreign Bodies** frequently become embedded in the corneal substance and produce symptoms of irritation, with considerable pain. Very sharp foreign bodies may even penetrate into the anterior chamber. If the foreign body is superficial it may be removed by gently touching it with a wisp of absorbent cotton wrapped upon the end of a probe or stick, thus engaging it in the meshes of the cotton. If, however, it is so adherent to the cornea that it cannot be removed in this manner a drop or two of a 2 per cent. solution of holocaine should be instilled to produce anæsthesia, after which the foreign body is to be picked out by means of a spud (Fig. 137) or needle, care being taken to produce as little abrasion of the corneal epithelium as possible. The instrument should be made sterile before using, and

FIG. 137.

Eye spud.

the eye should be flushed with a solution of boric acid both before and after the removal of the foreign body. If the foreign body has penetrated the anterior chamber it is sometimes necessary to pass a broad needle, or keratome, through the cornea behind the foreign substance, to act as a support in order to prevent the efforts at removal from pushing it entirely into the anterior chamber or into the lens, where it might produce greater injury. If it has been necessary to work at the eye for some time to effect the removal of the foreign body, and there has resulted considerable irritation, a drop of atropine should be instilled and a light bandage applied for a day or two.

Oyster Shucker's Keratitis is a name which has been given by Randolph to a condition of the cornea met with in oyster shuckers which has been produced by injury from the minute particles of oyster shells. The condition

is due to the chemical properties of the shell, and should be treated by frequent irrigations with a cleansing lotion and the instillation of atropine.

A Corneal Abrasion may be so superficial as to remain unseen with the naked eye or magnifying glass, and yet it produces marked pain. There may be a history of something suddenly striking the eye, and the patient has intense pain, photophobia, and lacrymation. If the abrasion cannot be detected by means of oblique illumination a drop of a fluorescine solution will stain that portion of the cornea which is denuded of the epithelium a light

FIG. 138.

Rupture of the sclerotic. (Sichel.)

green, sometimes producing a very striking picture on what has otherwise appeared as a normal cornea.

Treatment. The treatment of the condition consists in thoroughly cleansing the conjunctiva and cornea with a solution of boric acid and the application of a bandage for a day or two.

Penetrating Wounds of the Cornea permit the escape of the aqueous humor, and are frequently accompanied by prolapse of the iris. (See Plate V., Fig. 7.) The eye should be thoroughly cleansed, and, if possible, the prolapsed iris replaced. If, however, the iris does not remain in position the prolapsed portion should be excised,

as is done in iridectomy. Atropine should be instilled, a light bandage applied, and if there is much reaction cold compresses may be employed through the bandage. If the wound in the cornea should be long the edges may be approximated by means of one or two fine silk sutures.

Burns of the Cornea are to be treated by the removal of any substance producing the burn, and the neutralization of alkalies or acids, the instillation of atropine, and the use of an oily preparation, as sterile olive oil or purified petrolatum.

Injuries of the Sclera. **Wounds** of the sclera in which the entire thickness of the latter membrane has not been involved, as a rule, get well quickly after cleansing of the eye and the application of a bandage.

Rupture of the sclera by a blow upon the eye is, however, a much more serious matter. It occurs almost always without any corresponding opening in the conjunctiva, and may be accompanied by an escape of part of the vitreous and even the lens beneath the conjunctiva. If the latter condition is found the conjunctiva is opened, the lens removed, the wound made thoroughly aseptic, and the conjunctival opening sutured and a bandage applied. The patient should rest in bed and have cold applications to the eye through the bandage. If there has been an escape of a large amount of the contents of the eyeball, enucleation becomes necessary. If the scleral rupture is small and the interior of the eye is clouded on account of the hemorrhage present, the eye is to be thoroughly cleansed, atropine instilled, a pressure bandage applied, and cold compresses employed. If the injury occurs in the anterior portion of the sclera and involves the ciliary body, the loss of vision by a tedious inflammatory process, or even the affecting of the other eye through sympathetic inflammation, may follow. In such cases it is necessary to consider the rules for the removal of an eyeball. (See page 162.)

If **foreign bodies** have penetrated the sclera and lodged inside of the eyeball an effort should be made to ascertain

their position and to remove them if possible. Sometimes they can be distinctly seen by means of the ophthalmoscope, if the patient comes under observation shortly after the injury has occurred and before the interior of the eye has filled with blood. Their location, if in the retina, may also be determined by means of testing the field of vision, if this can be done, their position being noted by the appearance of a scotoma. In all instances, however, no matter how hazy the media may appear they can be located by means of a skiagraphic examination with the Röntgen rays.

If the foreign body has been located inside of the eye, and is of iron or steel, an attempt should be made to remove it by means of an electro-magnet, such as Hirschberg's instrument, the point of which is introduced through the wound of entrance to the position occupied by the foreign body, or if the foreign body has passed to the opposite side of the eyeball the magnet is introduced through a new wound made for the purpose in the immediate neighborhood of the foreign body. If the large electro-magnet of Haab is employed the eye of the patient containing the foreign body is approached toward the point of the magnet and the current turned on. Between the small magnet of Hirschberg and the large magnet of Haab there are intermediate sizes (Johnson's, Lippincott's, and Sweet's) of sufficient strength to extract foreign bodies in many instances by the approximation of the point to the wound of entrance. In the employment of any variety of magnet the point is placed in position either inside or outside of the eyeball before the current is turned on.

If the foreign body, however, is of some substance which cannot be attracted by the magnet, such as glass, wood, or brass, an effort should be made to remove it with small forceps, and, failing in this, the question of enucleation must be considered. This has been discussed under treatment of sympathetic inflammation. (See page 162.)

Injuries of the Iris and Ciliary Body. Rupture of the iris either single or multiple may occur as the result of a blow upon the eyeball. If it occurs at the ciliary border of the iris the condition is known as *iridodialysis*, and a false pupil is produced (Fig. 139, and Plate V., Fig. 4). The ruptures may appear as numerous fissures in the iris tissue or as notches at the pupillary margin. There is hemorrhage into the anterior chamber which sometimes obscures the condition. Rupture of the sphincter of the iris sometimes produces mydriasis which is not altered by treatment.

Treatment. The treatment consists in the instillation of atropine to put the iris at rest, and the application of a bandage for a few days.

FIG. 139.

Iridodialysis. (Nettleship.)

Foreign Bodies sometimes lodge in or upon the iris. (See Plate V., Fig. 6.) The anterior chamber should be opened by means of a keratome, which is entered at the corneo-scleral junction, and if the foreign body cannot be removed with the iris forceps or magnet, an iridectomy should be performed, that piece of the iris tissue containing the foreign body being excised.

Aniridia is that condition in which the iris has been completely detached from its insertion, and sometimes follows very severe injuries.

Injuries of the Ciliary Body usually occur at the same time as injuries to the sclera or iris, and inasmuch as this is the most dangerous region of the eye there is great possibility of sympathetic trouble following. Therefore,

if any attempt is made to save the eye after an injury in this region it should be done according to the directions given in the prophylactic treatment of sympathetic ophthalmia. (See page 162.)

Injuries of the Lens. Injuries of the lens usually produce traumatic cataract, the treatment of which has been described on page 250. The symptoms and treatment of dislocation of the lens have also been described on page 251. If a foreign body lodges in the lens, and is of steel or iron, an attempt should be made to remove it by means of the electro-magnet. If the lens is opaque, and the foreign body is within it, extraction should be performed.

Injuries of the Orbit. One of the most frequent injuries to the orbit is a fracture of one or more of the bones entering into its formation. Occasionally there are penetrating wounds, as from the ferrule of an umbrella. Foreign bodies also lodge in the orbital cavity.

If the injury results in a severe inflammatory process it should be treated according to the rules given under orbital cellulitis. In all instances, as soon as the patient is seen, the eye should be thoroughly cleansed and free drainage established. The early application of cold compresses oftentimes prevents marked swelling and modifies the subsequent inflammatory process. If a foreign body is present it should be removed. If any of the muscles have been injured their ends should be re-attached.

Dislocation of the Eyeball is occasionally met with, but is exceedingly rare. The danger of such an accident is injury to the optic nerve and destruction of vision.

Treatment. The treatment consists in reducing the dislocation as quickly as possible, and the application of a bandage. In some instances it is necessary to perform a canthotomy before the dislocation can be reduced.

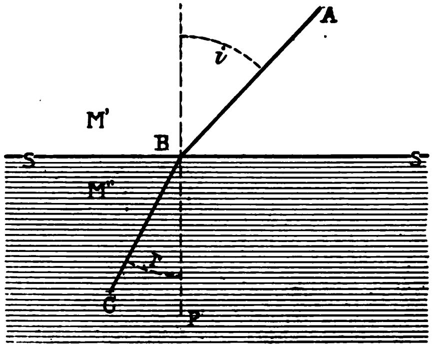
The condition of **Enophthalmos**, or a sinking of the eyeball into the orbital cavity, sometimes follows injury.

CHAPTER XVII.

NORMAL AND ABNORMAL REFRACTION AND ACCOMMODATION.

Refraction is that condition in which rays of light passing from one transparent medium into another of different density are deviated from their course. The *normal* of a surface is that ray which falls perpendicularly to the surface which separates the two media, and is not refracted but continues in a straight course. A ray of

FIG. 140.



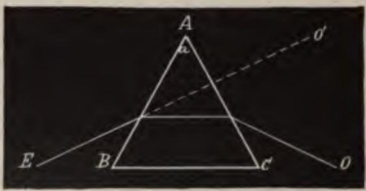
Law of refraction: A B, incident ray; B C, refracted ray; M′, rare medium; M″, dense medium; S S, surface separating media.

light is refracted toward the normal, or perpendicular, of the denser medium when it enters in a direction other than perpendicular to its surface. When a ray of light passes from a denser into a lighter medium under the same conditions regarding direction it is refracted from the normal. An *incident ray* of light is a ray that impinges on the surface of a refracting medium.

Index of refraction is a term applied to the relative time required by rays of light to travel a given distance through media of different densities. If we represent air by 1.00 the index of refraction of crown glass is 1.53, of rock-crystal pebble 1.56, of flint glass 1.70, of water 1.33, of the cornea 1.33, and of the crystalline lens of the eye 1.42.

Prisms. A prism is some refracting substance of the shape of a wedge having a base and an apex which are joined together by two inclined surfaces. The angle which is formed by the two surfaces is the refracting angle of the prism, the *apex* being the thin edge, and the *base* the thick edge.

FIG. 141.



Refraction by a prism.

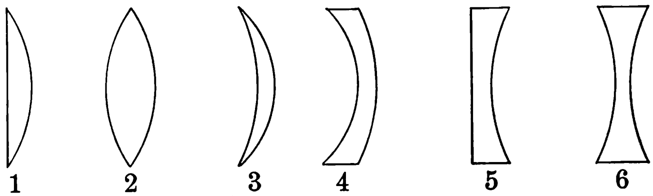
A ray of light in passing through a prism is refracted *toward the base*. This is true because upon entering the prism the ray is passing from a rarer to a denser medium and is refracted toward the normal; but upon leaving the prism it is passing from a denser to a rarer medium and is therefore refracted from the normal, or toward the base. The relative relation of rays of light to the prism as they enter and leave it is not changed.

Prisms are numbered in *degrees*, in *centrads*, and in *prism dioptres*. The first is the method generally employed, and the number of the prism corresponds to the refracting angle; thus, we have prisms of 1°, 2°, etc. In centrads we have 1^{∇}, 2^{∇}, etc., a centrad being equivalent to a deviation which has an arc of $\frac{1}{100}$ of the radius. In prism dioptres we have 1^{Δ}, 2^{Δ}, or 1 P. D., 2 P. D.,

etc., a prism dioptre being equivalent to a deviation which has a tangent of $\frac{1}{100}$ of the radius. In the lower numbers the three methods are for practical purposes about equal. The position of the prism is indicated by the direction of its base; thus, when we say "*base out*," we mean the base is placed toward the temple, and when we say "*base in*" the base is placed toward the nose. The strength of a prism may be determined by observing the amount of deviation on a chart prepared for the purpose, a centimetre deviation at one metre distant indicating a 1° prism.

Lenses. A lens is a transparent medium, with one or both surfaces curved, employed for refracting rays of light. There are many different forms of lenses.

FIG. 142.



Forms of lenses.

A **Biconvex Lens** is a lens in which both surfaces are convex, and which practically consists of two plano-convex lenses with their plano surfaces approximated in such a manner that their principal axes coincide.

A **Biconcave Lens** is a lens in which both surfaces are concave and in which two plano-concave lenses are so arranged that their principal axes coincide.

A **Plano-convex Lens** is one in which one surface is convex and the other plane.

A **Plano-concave Lens** has one surface concave and the other plane.

A **Converging Meniscus** is a lens in which one is convex and the other surface concave, the con face being the stronger of the two. A **Diverging**

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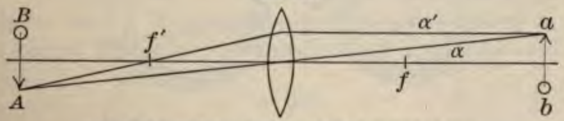
point. The **conjugate foci** of a lens are two points bearing such a relation to the lens that when an object is placed at one point, an image of the object will appear at the other point.

Images. An image of an object is a reproduction of the form of that object in a plane where some of the rays of light from every point of the surface of the object are brought to a focus. This plane is known as the *focal plane.*

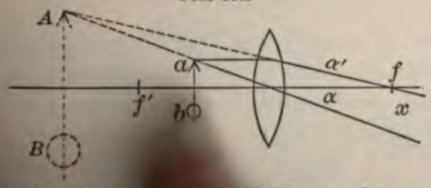
FIG. 143.



Real inverted image formed by a convex lens.

In physiological optics two kinds of images are known, the **real** or **inverted,** and the **virtual** or **upright.** The real image is found on the side of the lens opposite to the object, and may be projected on any flat surface. The virtual image is on the same side of the lens as the object, and is formed only in the mind of the observer. All

FIG. 144.



Virtual erect i... ...d by a convex lens.

...concave le... ...irtual. All images from ...where th... ...placed between the ...f the l... ...lens itself are also ...laced beyond the

...s strong if it ...low refractive

power. · The principal systems of notation for classifying the strength of lenses are the inch and the dioptric systems.

The Inch System of Notation is based on an inch as a unit of focal distance. Naturally it differs in various countries according to the length of an inch, the French, German, and English inches all being of different lengths. The system consists in the employment of the unit as the numerator, and the focal distance of a lens as the denominator of a fraction representing the strength of a lens. Thus, a lens having a focal distance of 1 inch would be $\frac{1}{1}$; a lens having a focal distance of 4 inches would be $\frac{1}{4}$.

FIG. 145.

Ophthalmic test case.

This system of notation has been practically replaced by the dioptric system because of the uniformity of the latter.

The Dioptric System has for its unit the French dioptre. The *dioptre* is a lens with a focal distance of 1 metre, or 39.4 inches. A lens having a focal distance, therefore, of 39.4 inches is known as a lens of 1 dioptre; a lens with half this focal distance is known as a lens of 2 dioptres; a lens of twice this focal distance is known as a lens of 0.50 dioptre focal power. The letter "D." is usually employed to express the word dioptre.

The Trial Case. The trial case is a box containing a number of lenses, both convex and concave spherical and convex and concave cylindrical, usually arranged in pairs, and with which the refraction of the eye is tested.

The convex and concave spherical lenses are of varying strengths from 0.12 D. to about 20 D. In the weaker lenses there are more divisions of a dioptre than in the stronger lenses; thus, up to 2 D. the division is usually in eighths, giving us 0.12 D., 0.25 D., 0.37 D., 0.50 D.,

FIG. 146.

Trial frames.

0.62 D., 0.75 D., 0.87 D., 1 D., etc. The cylindrical lenses vary from 0.12 D. to about 8 D., the weaker lenses also having more frequent divisions than the stronger. The lenses are mounted in metal cells (Fig. 147) so that they can be held in position in a pair of trial frames

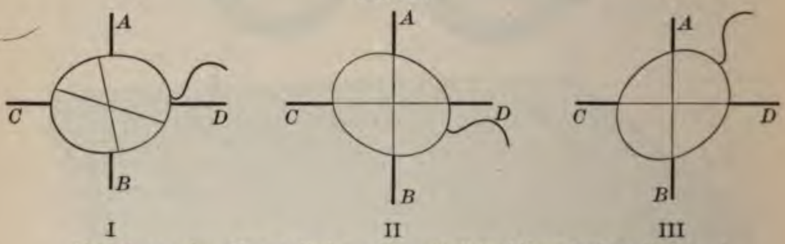
FIG. 147.

Lens mounted in cell.

(Fig. 146) in front of the eyes, the latter being marked in degrees, so that the exact axis of any cylindrical lens or prism may be determined. There are also prisms of different strengths, a maddox rod, various disks, stenopæic slits, and colored glasses.

Recognition of Lenses and Estimation of Strength. If a *convex spherical* lens held in the hand be rapidly moved from side to side or from above downward in front of the eye at the same time that some object is being observed through the lens the object will appear to move in a direction opposite to that in which the lens is moved. In other words, the object is said to move *against the lens*. If a *concave spherical* lens be employed in the same manner the object will move *with the lens*. If a cylindrical lens is moved from side to side and from above

FIG. 148.



Distortion produced by a cylinder. Determination of the axis of a cylinder. A right-angled cross, *A B C D*, is seen through a glass containing a cylinder. If (I) the axis of the cylinder does not coincide with either *A B* or *C D*, the cross will appear twisted, so that the arms no longer make a right angle. The cross, however, is not displaced as a whole either to one side or the other. If now the glass is rotated until the axis of the cylinder coincides with one arm of the cross—*e. g.*, *A B* (II)—the cross will appear right-angled and unbroken. The same thing will happen if the glass is rotated 90° more (III), so that the axis of the cylinder coincides with *C D*. (Duane.)

downward at the same time that an object is being observed it will be noted that when the lens is moved in the direction of its axis no movement of the object takes place, but when it is moved in a direction at *right angles to its axis* the object moves *against the lens* with the *convex cylinder* and *with the lens* with a *concave cylinder*. These movements are taken advantage of in ascertaining the strength of different lenses. For example, if we are examining a convex lens and find that in viewing an object through it that the object moves against the lens we can ascertain the strength of the lens by placing over

it that concave lens which will exactly neutralize the convex lens, and thus prevent any movement whatever. Likewise convex cylindrical lenses are neutralized by concave cylindrical lenses of similar strength with their two axes exactly approximated.

In order *to find the optical centre of a lens* it is necessary to hold the lens a few inches above two lines which cross each other at right angles; when the vertical and horizontal lines as seen both through the lens and outside the lens are continuous and unbroken, that point in the lens where the two lines cross is its optical centre. The *axis of a cylindrical lens* may be ascertained in the same way.

Sometimes it is necessary to combine cylindrical with spherical lenses. When this is done the spherical surface is ground on one side and the cylindrical surface on the opposite side, and the cylindrical lens must always be given an axis, as *it refracts only at right angles to that axis.* The following is an example of such a lens: $+$ Sph. 2.00 D. $\bigcirc$ $+$ Cyl. 1.00 D. ax. 90°. Such a lens is known as a *sphero-cylindrical lens.*

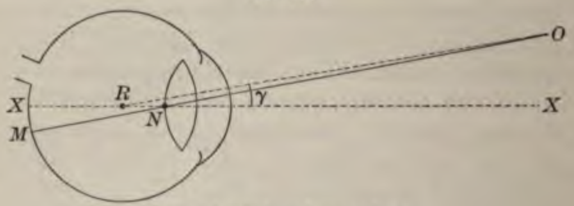
Optical Properties of the Eye. The eye has been likened to a photographic camera, the retina representing the ground glass plate upon which the images are focused, and the dioptric apparatus of the eye representing the lens system which produces the inverted image that falls upon the retina. The dioptric apparatus of the eye consists of the cornea, aqueous humor, crystalline lens, and vitreous humor. Inasmuch as the index of refraction of the cornea, aqueous and vitreous humors is approximately 1.33 and of the lens 1.45 the rays of light must be refracted differently in passing through each. Because of this condition the principal deviation in the direction of rays of light entering the eye is found at the anterior surface of the cornea, and at the anterior and posterior surfaces of the crystalline lens. The deviation at the anterior surface of the cornea is, of course, [illegible] because the rays are passing from a rarer to a [illegible] medium and are consequently bent toward the [illegible] This condition is increased by the shape of the [illegible]

When the anterior surface of the lens is reached a further deviation takes place because the rays pass from the aqueous to the denser lens, and at the posterior surface of the lens the normals are diverging, and as the rays of light pass into the vitreous, which is less dense than the lens, they will be bent away from the normals; the deviation, therefore, will be in the same direction as before, in each case convergence being produced. The whole dioptric apparatus of the eye, therefore, may be practically considered as a convex lens, the object of which is to collect the rays of light and produce convergence and the formation of a real image.

Cardinal Points of the Eye. The **nodal point** (N), which is practically the optical centre of the dioptric system, is situated at the posterior portion of the crystalline lens, and rays passing through this point are not refracted and form secondary axes. This point is about 7 mm. behind the cornea.

The **optic axis** (XX) is an imaginary line passing through the centre of the cornea and the nodal point and which falls between the macula lutea and optic disk if continued backward.

FIG. 149.



Cardinal points and axes of eye.

The **visual axis** (MNO) is a line which joins the object observed with the macula, passing through the nodal point; the **line of fixation** (RO) joins the **centre of rotation** with the object being observed, and for practical purposes corresponds with the visual axis.

The **angle gamma**, which varies with the refraction of the eye, is the angle ORX, and is formed by the line of

fixation and the optic axis. This angle is large in hyperopia and small in myopia, these variations sometimes producing an appearance of an apparent squint.

The **angle alpha** is the angle which is formed by the visual axis and the major axis of the corneal ellipse, and must be distinguished from the angle gamma.

Refraction of the Eye. The refraction of an eye may be divided for practical purposes into *emmetropia* and *ametropia*.

Emmetropia. Emmetropia represents a standard of a normal eye, and is that condition in which parallel rays of light are brought to a focus upon the retina and divergent rays behind the retina.

Ametropia is a condition of abnormal refraction in which parallel rays of light are not brought to a focus upon the retina. The forms of ametropia are *hyperopia*, *myopia*, and *astigmatism*.

Accommodation. Accommodation is that power which the eye possesses of so altering the refractive strength of its dioptric apparatus that rays of light proceeding from objects at different distances are brought to a focus upon the retina, producing distinct images. The dioptric apparatus of the eye cannot be properly focused for two points at different distances at the same time, and must, therefore, be changed for every distance at which objects are observed.

The **mechanism of accommodation** has been the subject of much discussion, and many theories have been proposed concerning it. The one which is perhaps most generally accepted is that during accommodative effort the ciliary muscle contracts, thereby drawing forward the choroid and relaxing the suspensory ligament of the capsule in which the lens rests; the latter being an elastic body and having the tension of its capsule lessened, increases its convexity, thereby increasing the refractive power and the ability to see near objects distinctly. principal change in the curvature of the lens affects anterior surface. This theory was proposed by Helm

When the eye is in the state of greatest refract

nearest point at which small objects can be distinctly seen represents the *punctum proximum*, which naturally varies with the amount of accommodative effort which a patient possesses.

When the eye is in the state of rest, the accommodation being completely relaxed, the most distant point at which vision is distinct is the *punctum remotum.*

The **range of accommodation** is represented by the distance between the punctum proximum and punctum remotum, the **amplitude of accommodation** being the difference between the refractive power of the eye at rest and the refractive power of the eye during the greatest effort at accommodation. The latter is sometimes expressed in dioptres, that convex lens which would have to be placed in front of the eye as a substitute for accommodation for the near-point representing the amplitude. Inasmuch as a 1 D. lens has a focal distance of 100 cm., if the near point of an eye was at 10 cm. the amplitude of accommodation would be represented by 100 divided by 10, or 10 D.

The power of accommodation becomes less and less as age advances, the near-point receding from the eye, and this condition is brought about chiefly by loss of elasticity of the lens.

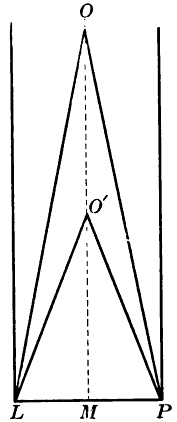
The following table shows the amplitude of accommodation at different ages :

Years.	*Range of Accommodation.*	*Near-point.*
10	14 D.	2¾
15	12 "	3
20	10 "	4
25	8 5 "	4½
30	7 "	5½
35	5.5 "	7
40	4.5 "	8¾
45	3.5 "	11½
50	2.5 "	16
55	1.75 "	23
60	1 "	39.5
65	0.75 "	...
70	0.25 "	...
75	0 "	...

Convergence is that power which the eye poss-
directing the visual axes of the two eyes a

within infinity. When the eyes are directed at an object in infinity the visual axes are said to be parallel, and there is, therefore, no convergence, but when an object nearer than infinity is being observed so that the visual axes of the two eyes are directed toward it there must be a certain amount of convergence, and this amount increases as objects nearer to the eyes are looked at. The convergence is produced by contraction of the internal recti muscles.

FIG. 150.



Convergence of the eyes. *O M*, median line; *L M P*, base line, or distance between the eyes; *L O P*, one metre angle, and *L O′ P*, two metre angles convergence.

The *unit of convergence* is sometimes called the *metre angle*, and is that angle which is formed by the visual lines with the median line at a distance of one metre, and must differ according to the length of the base line. Thus, L O P represents one metre angle of convergence for both eyes, whereas L O′ P represents two metre angles of convergence, these points representing the amount of convergence which will have to be made by the two eyes [illegible]erve distinctly objects situated at these points. [illegible] L O′ M [illegible] respectively one and two [illegible]ve.

The **far-point of convergence** is that point to which the visual lines are directed when convergence is at rest, and the **near-point of convergence** is the point at which the visual lines are directed when the eyes are exerting the greatest amount of converging power which they possess. The distance between these two points has been termed the **amplitude of convergence.**

As it can be definitely determined how much accommodative power an eye possesses for a given point and how much converging power the same eye possesses for the same point, the relation between these two is maintained, as a rule, under normal conditions. Any disturbance of this relation, as pointed out elsewhere, is apt to produce some abnormal ocular conditions.

Methods of Determining the State of Refraction. Three principal methods are employed at the present time for determining the condition of the refraction of an eye, and it is best in most cases to employ them all so that the results obtained by one method may be corroborated by the others. The first method is the estimation of the visual acuity for both near and distant vision by means of *the test types and lenses;* the second method is by means of *retinoscopy;* the third by means of the *ophthalmoscope.*

Determination of Refraction by Test Types and Lenses. In the determination of the refraction by the first method test cards, trial lenses, and a pair of trial frames are required. The trial frames are placed in front of the eyes, one eye being tested at a time while the other is covered with an opaque disk to prevent the patient from using it. Distant vision is ascertained according to the methods given in Chapter I. A patient being seated six metres from the test card, if he should read 6/6 there is probably no myopia or astigmatism; in other words, the eye may be emmetropic or hyperopic. If a weak convex spherical lens (+ S. 0.50 D.) is placed in front of the eye and the patient is still able to read the 6/6 line the eye is hyperopic, and the amount of the manifest

hyperopia will be corrected by the *strongest convex spherical lens* with which he can read 6/6. The total hyperopia can only be measured after the ciliary muscle has been paralyzed by means of a cycloplegic. The difference between the manifest and the total hyperopia is usually known as latent hyperopia.

If the patient has 6/6 vision and it is made worse by the weak convex spherical lens, he may have latent hyperopia, or the eye may be emmetropic.

If the vision is subnormal, for example, 6/9 or 6/12, the condition of the eye may be myopic, astigmatic, or highly hyperopic. There may also be a combination of these errors. If the vision is materially improved by means of a convex spherical lens the condition is hyperopic. If the condition is made worse by the addition of the convex spherical lens and improved by the addition of concave spherical lenses, the amount of his myopia is represented by the *weakest concave spherical lens* with which normal vision is obtained. If, however, neither convex nor concave spherical lenses improve the vision, astigmatism may be present and the use of *cylindrical lenses,* rotated in the trial frames until the axis is found which gives the best vision, will have to be employed to determine the amount of astigmatism.

The *accommodation should also be tested* in order that we may find the near-point and far-point for the smallest type which the patient is able to read, as well as the point at which the type appears to be the clearest. Information as to the character of the refraction can sometimes be obtained from this test, because in myopia the [illegible] will be held closer than in emmetropia or hyperopia, [illegible] presbyopia it will be held further from the eye [illegible]mal.

[illegible] Skiascop[illegible] is the determination of the [illegible] of th[illegible]e by studying the conduct [illegible]e pupil when light is re- [illegible]r concave mirror. The [illegible]d the mirror that it

intercepts the rays of light reflected from the fundus. The source of light may be placed behind and a little above the patient's head, or to the side and slightly in front of the observer, the former position being the one usually employed with the concave mirror and the latter position with the plane mirror. The observer is seated

FIG. 151.

Retinoscopic mirror.

at a distance of one metre in front of the patient, and, holding the retinoscopic mirror before his eye, reflects the light into the eye of the patient. A reddish disk will be seen to fill the pupil, which moves in various directions as the mirror is slightly rotated on its axis. In emmetropic eyes, on movement of the mirror, the red-

dish disk disappears suddenly, apparently leaving the pupil in all its parts about the same time. In hyperopic eyes, if a plane mirror is used, the disk of light moves *in the same direction* across the area of the pupil with the mirror, followed by a relatively deep shadow. In myopic eyes, the image moves *in the opposite direction* to the movement of the mirror, also followed by a shadow. To estimate the refraction of an eye a convex or concave spherical lens is placed before it, and the strength gradually increased until the shadow conducts itself as in emmetropia. A *point of reversal* of the shadow will be found, that is if the shadow is moving against the mirror it will move with, or if it is moving with the mirror it will move against, and when this point of reversal is found by adding lenses of increased strength in front of the eye, the mirror being 1 metre distant from the patient's eye, the glass which produces this condition is approximately the one required to correct the error of refraction.

To ascertain the point of reversal it is necessary to observe the nearest point to the eye from which movement of the disk of light in one direction is obtained, and the most remote point from the eye from which movement in the opposite direction can be noted. The point *midway* between these two represents the point of reversal. It is not necessary that the point of reversal should always be obtained at one metre, though this distance is the most convenient for practical work. Should it be found at any other point, however, the lens whose focal distance is the same as the distance from the point of reversal to the eye, added to any lens which may be already in front of the eye in myopia and subtracted in hyperopia, will represent the refractive condition of the latter.

In examining the refractive condition of the eye l retinoscopy the pupils should be widely dilated, the roo dark, and the patient should look in the direction of tl mirror, though not directly at it, and beyond. If asti

matism is present it will be manifested by a *broad band of light* which is seen on the red background, and moving with or against the plane mirror, according to whether the condition is hyperopic or myopic. The different meridians of the eye must be tested separately, the most frequent positions for the two principal meridians in astigmatism being vertical and horizontal. In this way astigmatism, if any exists, may be detected, the difference between the lenses required to produce an emmetropic condition in different meridians at right angles to each other being the estimate of the astigmatism present. This method of examination determines the total astigmatism.

If a concave mirror is employed in making the examination the movements of the shadow will be the opposite of the movements observed with the plane mirror; that is, the shadow moves *with* the mirror movement in myopia and *against* the mirror movement in hyperopia.

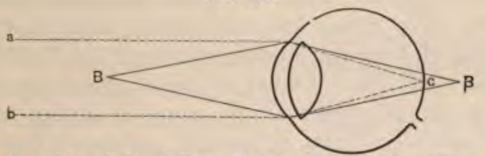
The determination of the refraction of the eye by the use of the *ophthalmoscope* has been described on page 41.

Emmetropia. When the accommodation is completely relaxed and the images of all distant objects are distinctly focused upon the retina the eye is said to be emmetropic. The distant vision of such an eye is not improved by any lenses, and glasses do not have to be used for near work until the age of presbyopia is reached; as a rule, such an eye can be employed without any resulting fatigue. An emmetropic eye is the standard eye, and any deviation from this condition constitutes one of the forms of ametropia, which are hyperopia, myopia, and astigmatism.

Hyperopia. When the accommodation is completely relaxed and parallel rays of light are brought to a focus behind the retina and divergent rays even further behind the retina, the eye is hyperopic. Inasmuch as such an eye at rest is adapted for convergent rays the eye cannot see distinctly until the accommodation has been so employed as to increase the convexity of the crystalline lens, or until a convex lens is placed in front of the eye, the strength being such as to render the rays sufficiently con-

vergent; therefore, an eye which is hyperopic and unprovided with a convex glass must necessarily at all times use an excessive amount of accommodation for both near and far objects. The result of this excessive use of accommodation is more or less spasm in the ciliary muscle and a certain series of symptoms.

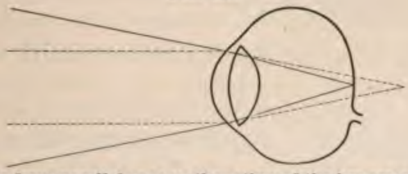
FIG. 152.



Passage of parallel and divergent rays into an emmetropic eye. (Norris and Oliver.)

Symptoms. If the amount of hyperopia is small the vision will, as a rule, be quite distinct for distance. After employing the eyes, however, for close work, thus producing a strain upon the accommodation, there may be more or less headache, referred to any portion of the head, though most frequently found in the frontal and temporal regions. There may be some blurring of the

FIG. 153.



Inability to focus parallel rays on the retina of the hypermetropic eye. (Norris and Oliver.)

print in reading, as well as slight congestion of the eyeballs, and occasionally ciliary pain referred to the back of the eyes. These symptoms of *asthenopia* are more pronounced if the patient is not in perfect health, or is of sedentary habits. For this reason patients who have plenty of out-door exercise and spend a large amount of

time in the open air are frequently not troubled by relatively large amounts of hyperopia. All the symptoms of hyperopia are, as a rule, found to be increased by the use of the eyes for near work.

If hyperopia is present, as the patient approaches the age of presbyopia, his distant vision will become poor, and it will be necessary for him to use glasses for near work much earlier than one whose eyes are emmetropic.

Causes. The most frequent cause of hyperopia is a shortening of the antero-posterior diameter of the eyeball, when the condition is known as *axial hyperopia.* It may also be produced, however, by changes in the media and by a diminution of the refractive power of the dioptric apparatus of the eye. An absence of the crystalline lens, or aphakia, also produces a similar condition. It is the most frequent error of refraction, having been observed in about 70 per cent. of all eyes, and is usually congenital. At birth most children are hyperopic, but with subsequent development may become emmetropic or even myopic.

Varieties. It is customary to divide hyperopia into three varieties, the manifest, the latent, and the total.

The *manifest hyperopia* is the hyperopia which manifests itself while the accommodation is active, the amount being determined by the strongest convex spherical lens with which the patient can see most distinctly at six metres.

The *total hyperopia* is the amount which is found after complete paralysis of accommodation, and is represented by that convex spherical lens which will give the patient the most distinct distant vision.

The *latent hyperopia* is the difference between the total hyperopia and the manifest hyperopia, and can only be ascertained by the employment of a drug which paralyzes the accommodation.

Tests for Hyperopia. In making an ophthalmoscopic examination of the eye it will have been found according to the rules given in Chapter I. whether or not the

refractive condition of the eye was hyperopic. If the patient has been annoyed by the various symptoms of hyperopia the condition should be corrected.

The distant vision (vision at six metres) is tested for each eye separately, and in moderate amounts of hyperopia is usually good, and in young people may be even normal. Later in life, however, the vision in hyperopic eyes becomes reduced.

If the accommodation is now tested the punctum proximum will be found to be further from the eye than it is in emmetropia for the same age.

If a cycloplegic is employed to paralyze the accommodation and a retinoscopic examination is made at one metre distant the shadow will be found to move with the mirror, the point of reversal of the movement being ascertained by gradually increasing the strength of the convex lenses in front of the eye. That lens with which the point of reversal is found, less 1 D. for the over-correction in producing convergence of the rays of light at one metre, will give the total amount of hyperopia.

With the accommodation completely paralyzed, the convex spherical lenses are placed in front of each eye separately, the strength being gradually increased, until that lens is discovered which gives the patient the best distant vision.

Treatment. If the patient has symptoms of asthenopia that convex spherical lens should be prescribed which will give the most distinct distant vision and enable him to use his eyes for near work without noticeable strain. The question as to whether the patient should wear the glasses constantly or for near work only must largely depend upon the symptoms of which he complains. If there is more or less constant headache and a feeling of pain in the eyes, whether the patient is using them for near work or not, the glasses should be worn constantly. If, however, the symptoms of discomfort are present only during the employment of the eyes for near work, such as reading, writing, etc., the glasses may be prescribed

for use in this work only. In cases of convergent strabismus it is necessary for the patient to wear the glasses constantly in order to relieve the strain upon the accommodation and convergence as much as possible.

In all cases under forty years of age it is necessary that a cycloplegic be employed to determine the total hyperopia. The full amount thus determined may not be prescribed at once, but it forms a basis upon which to estimate the strength of the glasses which the patient should wear. If the patient's distant vision is considerably less than normal before the cycloplegic is employed and with the correcting glasses the vision is made normal, in most instances the patient can wear the full correction with comfort. If, however, the distant vision is normal before the cycloplegic is employed and a strong convex lens is required to correct the total hyperopia it is more than likely that only a portion of the full amount can be worn with comfort at first. In these cases it is necessary to increase the strength of the lens after it has been worn for a while, provided symptoms of asthenopia are again observed. In those cases of hyperopia which have passed into the stage of presbyopia two pairs of lenses will have to be worn, one to assist the distant vision and another to assist the near vision. It should be borne in mind that the refraction is slightly over-corrected in testing the distant vision (0.25 D. for 4 M.), so that about 0.25 D. should always be deducted from the result obtained at this distance before prescribing.

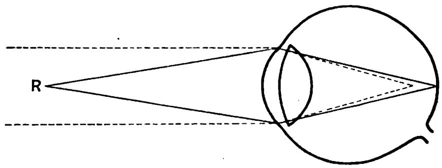
Aphakia. Aphakia is that condition in which there is an absence of the crystalline lens from its position behind the pupil. Aphakia may be produced either by the removal of the lens, as in cataract, or by dislocation. When the condition of aphakia is present the refraction of the eye must be corrected by the constant use of a convex spherical lens of about 10 D. to 12 D. for distant vision, and for near work an additional strength of 3 D. or 4 D. must be added. If, therefore, a patient was very myopic before he became aphakic the condition may

result in emmetropia or hyperopia The accommodation is abolished.

If an eye is aphakic there can usually be observed *tremulousness of the iris* upon the least movement of the eyeball, the *complete absence of accommodation*, and in the *catoptric test*, which consists in holding a light about a metre distant from the eye, and in which test if the lens is present, there will be noted three images, one on the anterior surface of the cornea, one on the anterior surface of the lens, and one on the posterior surface of the lens, the latter two will be found to be absent.

Treatment. The treatment consists in giving the patient for constant use that glass which will enable him to have most distinct distant vision, and another glass 3 D. or 4 D. stronger to compensate for his loss of accommodation and enable him to read or to perform near work.

FIG. 154.



Far-point in a myopic eye. (Norris and Oliver.)

Myopia. Myopia is that condition of refraction of the eye in which parallel rays are brought to a focus in front of the retina, the accommodation being completely relaxed. There are certain divergent rays, however, depending upon the degree of myopia present, which are focused upon the retina. In myopia, therefore, the parallel rays of light coming to a focus in front of the retina form *diffusion circles* upon the retina, and the image is blurred. In myopia the punctum remotum is at a distance less than infinity, and is the point at which the patient can read the smallest print most distinctly. The amount of myopia can also be determined by this point. There being 100 cm. in a

metre and the 1 D. lens having a focal distance of a metre being the standard, if the far-point is at 25 cm., 100 divided by 25 equals 4 D. of myopia. If the far-point is at 10 cm., 100 divided by 10 equals 10 D. of myopia. The punctum proximum in myopia depends upon the amplitude of accommodation.

Symptoms. The symptoms depend largely upon the degree of myopia. If the myopia is moderate in amount there will be no symptoms except indistinct vision for distance. Inasmuch as very little accommodative effort is employed the patient can use his eyes for near work with perfect comfort. If the degree of myopia is considerable the distant vision will be very indistinct. There may also be more or less discomfort upon the use of the eyes for near work because of the excessive convergence. Occasionally black spots are complained of as floating before the eyes, and there may be some photophobia. If the degree of myopia is very high the eyeball is more or less prominent, and the anterior chamber is deep. There is sometimes a divergent strabismus because so great an effort is required to converge the eyes for near work that this effort is given up with the resulting divergence.

With the ophthalmoscope low degrees of myopia seldom show any changes with the exception of a narrow patch of choroidal atrophy, which is crescent-shaped and lies to the outer side of the optic disk. In very high myopia, however, the myopic crescent, or even a posterior staphyloma, may be found. (See Plate VIII, Fig. 2, and Fig. 156.) If the condition is progressive, atrophic changes, accompanied by pigment massing, may take place in the macular region. In some cases hemorrhages are observed, the vitreous becomes degenerated and filled with opacities, and in very high cases detachment of the retina may result. In such cases the vision is naturally much reduced.

Causes. The most frequent cause of myopia is a lengthening of the antero-posterior diameter of the eye-

ball, the condition being known as axial myopia. In some cases it is due to an increased curvature of the cornea, or to an increase in the refractive power of the lens, the latter having been referred to elsewhere, as the beginning of the formation of cataract. A temporary myopia may also be produced by spasm of the ciliary muscle. The condition is most frequently found among the class of people who use their eyes to the greatest extent for near work, and it has therefore been called a disease of civilization. It may be increased by improper use of the eyes in near work, and the increase of the percentage of cases between the lowest and the highest classes in educational institutions is marked.

FIG. 155.

Section of a highly myopic eyeball: the retina has been removed. (Nettleship.)

FIG. 156.

Myopic crescent of a small posterior staphyloma. (De Wecker and Jaeger.)

The lengthening of the antero-posterior diameter of the eyeball may be brought about by pressure of the external eye muscles in excessive convergence, by inflammation of the layers of the eyeball, and by the shape of the orbits; the latter condition is particularly applicable to those persons whose faces are exceedingly broad, where an excessive amount of convergence is required.

Varieties. *Stationary myopia*, sometimes called simple myopia, is the myopia that develops in young persons, is of moderate degree, and does not progress. Where the myopia gradually increases and is accompanied by changes in the choroid and other portions of the eye, the condition is known as *progressive myopia.* *Malignant myopia*

is applied to those cases in which the destructive changes become most marked.

Prognosis. The prognosis is fairly good in low degrees of myopia, provided the condition remains stationary. If there is a tendency, however, to progress, the affection becomes very serious, and especially so if there are changes in the choroid or vitreous. The prognosis in malignant myopia is exceedingly bad as regards the retention of vision.

Tests for Myopia. When distant vision is tested it is always found to be less than normal, and with the increase in the degree of myopia present there is a corresponding decrease in the visual acuity. Except in the very high degree of myopia in which there are numerous choroidal changes, the near vision is good, but the patient will hold his work much closer to the eye than is done in emmetropia. A concave spherical lens placed in front of the eye increases the acuity of vision, and the weakest concave spherical lens with which the patient obtains the best vision at six metres is the estimate of the amount of myopia present. In young people it is necessary to employ a cycloplegic to paralyze the accommodation before testing, in order that spasm of accommodation will not result in the selection of too strong a lens. Patients who require a very high concave spherical lens for the correction of their myopia may require a lens which is 3 D. to 4 D. weaker with which to read or to perform their near work with comfort. Patients who have a myopia of 3 D. or 4 D. can sometimes perform their near work better without than with the glasses.

With the retinoscope at a distance of one metre the shadow moves against the lens, a plane mirror being employed, and the point of reversal is found by the addition of concave spherical lenses in front of the patient's eye. A lens of 1 D. for the under-correction added to that one through which the point of reversal is found at a distance of one metre represents the amount of myopia.

Myopic eyes are frequently large and prominent, with

deep anterior chambers and dilated pupils. If there is high myopia the patient presents the appearance of one who does not see well.

Treatment. The treatment consists in the prescribing of proper glasses, and in so regulating the habits of the patient as to prevent increase of the elongation of the eyeball, if possible.

It is important that children should not bend too low over their desks when at work. To overcome this defect, if present, desks have been made for the purpose. The latter should have an inclined top and the height should be such that the distance from the child's eyes to the work upon the desk is 14 or 15 inches. The illumination should be good and should come from the right side and behind, if the child is left-handed, or from the left side and behind if the child is right-handed. Books with small print should not be used. The general health should be attended to, and children with a tendency to myopia should not be permitted to use their eyes for near work for too long a period without rest. If myopia is present the individual having it should be placed sufficiently near the blackboard to enable him to see well, as frequently children are considered stupid when in reality they are sitting too far from the blackboard to see what is written thereon with their myopic eyes.

If the amount of myopia is small the patient experiences very little inconvenience, and, perhaps, is unaware that his distant vision is not particularly good. In performing near work his eyes are quite comfortable. Such patients may have their myopia corrected for distance, and employ their eyes in near work without the aid of glasses. If the myopia is greater than 3 D. it is better to give a glass for constant use which will fully correct it, and if the patient can perform near work with a weaker lens with greater comfort than with the full correction or no lens at all, this should also be given.

Patients who have in early life been obliged to employ a concave spherical lens of 2 D. or 3 D. for near work

are usually able to lay aside the glasses after the age of presbyopia, since in advancing presbyopia a convex lens of about this strength is required for near work.

It must be borne in mind, however, that in prescribing glasses for myopes each case is a law unto itself, and must be considered according to the conditions present. Some patients can wear the full correction with comfort, others can wear only a partial correction, and must have two sets of glasses. Musicians who frequently have their scores further from them than the ordinary reading distance will require three pairs of lenses, a pair for distance, a pair for near work, and a pair for their musical work. Such is also the case with individuals following vocations whose working distance is further from their eyes than the usual reading distance.

Operative Treatment of Myopia. Within a few years it has been suggested to remove the crystalline lens in high degrees of myopia. In such cases the condition of the fundus should be good, and the degree of myopia exceedingly high, with the eyes decidedly uncomfortable, or with a marked tendency to progress. A discission of the lens is first performed in order that it may become opaque, after which it is extracted. The operation, if performed, should be in those cases of myopia of higher degree than 15 D. It must be taken into consideration, however, according to the vocation of the patient, that, inasmuch as accommodation is lost by the removal of the lens, the patient may not be so comfortable as before removal. After removal of the lens for myopia of moderately high degree it is the rule for the patient to require a convex spherical lens for distance, and a stronger lens for near work

Astigmatism. This is a condition of the eye in which there is a difference in the curvature of some of the meridians of the dioptric apparatus, producing different degrees of refraction in the unequal meridians. In emmetropia, hyperopia, and myopia, the surfaces being spherical, rays coming from a luminous point are brought to a single

focus at certain distances behind the refractive surfaces. In astigmatism, however, the refracting surfaces not being spherical, rays coming from a luminous point are not brought to a focus at any single point, but at different points which correspond to the curvatures of the different meridians. The two principal foci, however, are those which correspond to the two meridians having the greatest and least curvatures, the distance between these foci representing the amount of astigmatism present.

Varieties of Astigmatism. There are two varieties of astigmatism, *irregular* and *regular*.

Irregular astigmatism is that variety in which there is a difference of refraction in *different portions of the same meridian*, and is caused by changes in the cornea or lens. This variety usually results from corneal wounds or inflammations, from conical cornea, from dislocation of the lens, or from some change in the refraction of different sectors of the lens.

Regular astigmatism is that variety in which the refraction in a given meridian is the same throughout, but there is a difference in the refraction of two meridians usually at right angles to each other. These are sometimes called the meridians of maximum and minimum refraction. With the ophthalmoscope the details of the fundus appear more or less distorted, and lenses of different strengths must be employed to see distinctly the bloodvessels in the meridians of greatest and least refraction.

Symptoms of Astigmatism. The symptoms are similar to those in other forms of ametropia, but are more marked. There is always more or less diminution of visual acuity for both distant and near vision. There is more or less headache following the use of the eyes, and, in fact, it is present to a certain degree during most of the time. These symptoms are produced more frequently by hyperopic than by myopic astigmatism. The headache and ciliary pain may be so severe at times as to produce nausea and vomiting. Very small amounts of astigmatism will at

times give rise to the most severe reflex symptoms in individuals who are nervous or in poor health. The various symptoms complained of may disappear entirely or become markedly less after a period of rest of the eyes, as in sleep.

Causes of Astigmatism. In almost all cases regular astigmatism is congenital. In many instances a history of astigmatism can be traced to several members of the same family. It is mostly due to a difference in the corneal meridians, though lenticular astigmatism may also be observed. If regular astigmatism is acquired it is usually brought about by some injury, either operative or otherwise. A normal eye has regular astigmatism to a slight degree because the cornea is not a segment of a sphere, but is ellipsoidal in shape.

Varieties of Regular Astigmatism. In regular astigmatism there are several varieties according to the refraction of the principal meridians. They are as follows: In *simple astigmatism* one meridian is emmetropic and the other hyperopic or myopic; we therefore have *simple hyperopic astigmatism* and *simple myopic astigmatism.*

In *compound astigmatism* the principal meridians are either hyperopic or myopic, but of different degrees. *Compound hyperopic astigmatism* and *compound myopic astigmatism* are included under this variety.

In *mixed astigmatism* we have the two principal meridians, hyperopic and myopic, respectively.

Inasmuch as in most cases of astigmatism the vertical meridian of the cornea is the meridian of greatest curvature, and the horizontal meridian the meridian of least curvature, we call this condition *astigmatism with the rule.* If the conditions of corneal curvatures are reversed we speak of *astigmatism against the rule.* In actual practice a convex cylindrical lens has its axis in the neighborhood of the vertical meridian, and a concave cylindrical lens has its axis in the neighborhood of the horizontal meridian if there is astigmatism with the rule. The reverse is true if there is astigmatism against the rule.

Tests for Astigmatism. If the reduced vision cannot be made normal by means of convex or concave spherical lenses, and no opacity of the media or disease of the fundus exists, astigmatism is suspected.

When the *ophthalmoscopic examination* is made, as it should be in every case under examination, if astigmatism is present it will be noted that the vessels of the two principal meridians will be distinctly observed by lenses of different strengths, and the difference between the strength of these lenses will represent approximately the amount of astigmatism, provided the accommodation of both the patient and the observer is at rest.

FIG. 157.

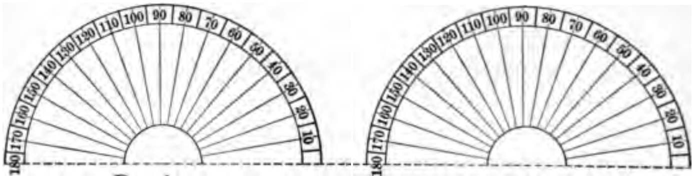
Stenopæic disk.

If the patient is directed to *observe a point of light*, for example, a small flame, and astigmatism is present the light will appear to be drawn out in the direction of the principal meridian

If a *stenopæic disk*, which is found in every complete test case, is placed in front of one eye, the other eye being covered, and turned in various directions it will be found that the best vision can be secured in a certain meridian and the poorest in the meridian at right angles to this, if astigmatism is present. With the stenopæic disk in each of these meridians lenses are employed until the best vision is secured, and the difference between the strength of the lenses thus employed will represent the amount of astig-

matism. The direction of the different meridians (axis of a cylindrical lens) may be indicated as shown in Figs. 158 and 159, the first being the method in general use in this country.

FIG. 158.

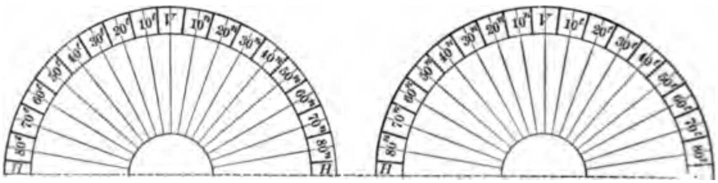


R (right eye) *L (left eye)*

Ordinary or parallel method of indicating the axis of cylinders or the direction of prisms. In each eye the position of the axis of the cylinder is denoted by the angle it makes with the horizontal, this angle being always measured from the right-hand side of the observer (left-hand side of the patient). The numbering thus runs through 0° to 180°, starting at the nasal side in the right eye and at the temporal side in the left. The horizontal is always denoted by 180°; vertical is 90°.

Because of the fact that the two principal meridians of the eye are of unequal refractive power a series of lines, most frequently arranged in the form of a clock dial, may

FIG. 159.



R (right eye) *L (left eye)*

Bisymmetrical method of indicating the axis of cylinders. In each eye the position of the axis of the cylinder is denoted by the angle it makes with the vertical meridian V (=0°), either on the nasal or on the temporal side, and is written as follows: 5n = 5° n, 5t = 5° t, etc , down to *H* = 90° (horizontal.

be employed to detect the meridians of maximum and minimum refraction. These are known as *astigmatic charts.* A patient whose eye is astigmatic looking at such a chart will find that certain lines are exceedingly

clear and distinct, while the other lines are more or less indistinct, those at right angles to the series most distinctly observed being the most indistinct. The direction of the lines which appear to be most distinct and those that are at right angles represent the two principal meridians of astigmatism.

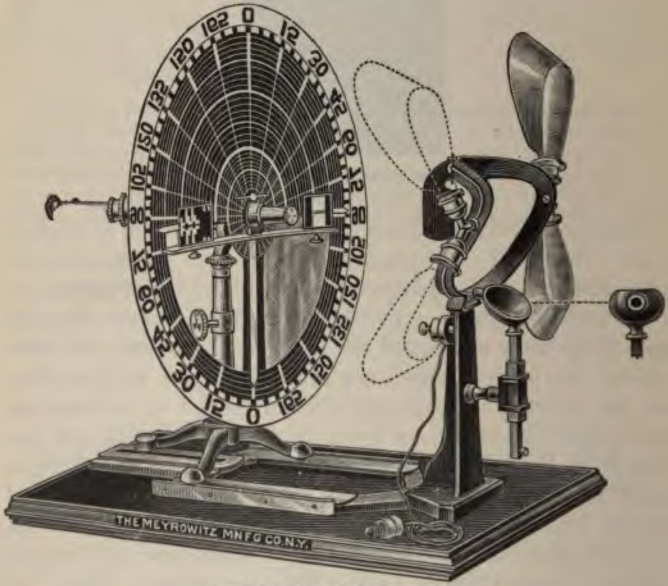
FIG. 160.

Astigmatic clock dial.

The *corneal astigmatism*, which is by far the most frequent form of astigmatism, may be approximately measured by the *ophthalmometer*. The instrument of Javal and Schiotz, or one of its modifications, is the one most frequently employed for clinical purposes. It consists of two mires, which are movable upon an arm that can be rotated to any meridian, attached to a telescope into which the observer looks from one end and the patient from the other. There is a chin rest for the patient, and when in position, with one eye covered, he is directed to look into the end of the telescope. The image of the mires is reflected upon the corneal surface and the instrument is focused by a to-and-fro movement. The two central mires are made to approximate, and the black line running through each is made continuous. This is called the *primary position*, and is indicated by a pointer, attached at right angles to the arm carrying the mires, in front of the large disk upon which the different meridians are marked. The primary position having been found and noted, the telescope is rotated through a quadrant of a circle so that the meridian at right angles to that which was first measured may be studied.

This is the *secondary position.* If the mires overlap, there is approximately one dioptre of astigmatism for each step thus covered. If the mires separate they may be approximated in this meridian, care being taken that the black lines in the centre of the mires are continuous with each other, when the telescope may be rotated to the primary position and the number of covered steps noted.

FIG. 161.



Javal-Schiotz ophthalmometer.

The overlapping of the steps represents the meridian of greatest curvature.

The measurement with the ophthalmometer is not altogether accurate, but is approximate. In the greater proportion of cases it will indicate the axis if care is taken to make the two black lines on the disk exactly continuous with each other. In many eyes the corneal astigmatism differs somewhat from the astigmatism of

the whole refractive apparatus, and, therefore, about 0.50 D. must be deducted from the result given by the ophthalmometer when the astigmatism is with the rule and about the same amount added to the ophthalmometric measurement when the astigmatism is against the rule.

With the *retinoscope* a distinct band of light will be observed moving with or against the plane retinoscopic mirror, according to whether there is hyperopic or myopic astigmatism. Spherical lenses may then be added until the point of reversal at 1 metre is found in each meridian separately, when the difference between the two meridians, less 1 D. of over-correction in hyperopic, and plus 1 D. of under-correction in myopic, will give the amount of astigmatism. Retinoscopic examination of astigmatic eyes may also be made by the use of cylindrical lenses placed at the proper axis.

Placido's disk has been referred to in the study of irregularities of the corneal surface, and may also be employed for the detection of astigmatism. When the image of the disk is reflected upon the cornea, if regular astigmatism is present the concentric circles will appear elliptical, and the long axis of this ellipse will represent the meridian of least curvature of the cornea. If there is no astigmatism of the cornea the rings will appear circular. If there should be irregular astigmatism the reflection upon the cornea will be distorted.

Treatment of Astigmatism. As in other refractive errors, treatment of astigmatism consists in the prescribing of suitable glasses to correct the defect. As a rule, such glasses must be worn constantly, but in the lower degrees of astigmatism where the patient's principal discomfort arises from the use of the eyes in near work they may be employed for near work only. In many cases of astigmatism in middle life, and, indeed, in many cases of very high astigmatism in young individuals, it is impossible to obtain normal vision. After the constant wearing of astigmatic glasses for a while, however, the vision frequently improves. If the lenses are accepted

with the axes vertical or horizontal the patient becomes more readily accustomed to them than if the axes are oblique. Lenses in the latter position frequently give rise to a sensation of walking up or down an inclined plane.

Inasmuch as most cases of astigmatism are associated with myopia or hyperopia, lenses to correct the latter conditions should be tried first in every case. As soon as a spherical lens of sufficient strength to give the best vision possible has been placed in front of the eye so that an increase of this strength blurs the vision, cylindrical lenses should be added. If the case is one of hyperopia it is better to try the cylinder in the test frame with the axis at or in the neighborhood of 90°, which is vertical. If, on the other hand, the astigmatism should be myopic, as has been previously stated, the concave cylinders will be accepted more frequently with the axis at 180°, or thereabouts, which is horizontal. The cylinder is gradually rotated in the trial frame until that axis is found with which the letters appear to be straight rather than slanting and the vision is the best for the glass employed, after which the strength of the cylinder is gradually increased until that lens is found with which the best vision can be obtained. The changes from one glass to another should be made quickly so the patient will be able to appreciate the difference between the two. If the case is one of simple astigmatism a cylindrical lens alone will be accepted. If the case is one of compound astigmatism a spherical lens combined with a cylindrical lens will be accepted. If the case is one of mixed astigmatism two cylinders, one hyperopic, the other myopic, will be accepted, usually at right angles to each other, or what is equivalent, a cylindrical and a spherical of opposite refraction should be employed. In irregular astigmatism we can sometimes find some meridian which gives better vision than any of the others, and the refraction of this meridian is then corrected with the proper cylinder. As an example of the correction of simple hyperopic astigmatism we have the following:

O. D. + Cyl. 2.00 D. axis 90°.

O. S. + Cyl. 1.75 D. axis 90°.

As an example of simple myopic astigmatism we have:

O. D.—Cyl. 2.00 D. axis 180°.

O. S.—Cyl. 1.75 D. axis 180°.

As an example of compound hyperopic astigmatism we have:

O. D. + Sph. 1.00 D. $\substack{\frown\\\smile}$ + Cyl. 1.50 D. axis 90°.

O. S. + Sph. 1.25 D. $\substack{\frown\\\smile}$ + Cyl. 1.75 D. axis 90°.

As an example of compound myopic astigmatism we have:

O. D.—Sph. 4.00 D. $\substack{\frown\\\smile}$ — Cyl. 2.00 D. axis 180°.

O. S.—Sph. 3.50 D. $\substack{\frown\\\smile}$ — Cyl. 1.50 D. axis 180°.

As an example of mixed astigmatism we have :

O. D. + Cyl. 2.00 D. axis 90 $\substack{\frown\\\smile}$ — Cyl. 1.50 D. axis 180°, or, + Sph. 2.00 D. $\substack{\frown\\\smile}$ — Cyl. 3.50 D. axis 180°, or — Sph. 1.50 D. $\substack{\frown\\\smile}$ + Cyl. 3.50 D. axis 90°, each correcting the same refractive error.

Anisometropia, which means a difference of refraction in the two eyes, is a condition which to some extent is present in most people. We employ the term, however, for those cases in which the difference is sufficiently great to make it necessary to employ a lens of different strength for each eye. One eye may be myopic and the other hyperopic.

The importance of the condition arises in the prescription of the glasses after the refractive error has been worked out with the test lenses, and no given rules can be followed for this condition. If one eye is emmetropic and the other ametropic, unless there should be some marked symptom of eyestrain, glasses would probably not be required. It is well in such cases, however, to cover the emmetropic eye occasionally for a short period

in order to prevent the ametropic eye to suffer from disuse. If the refraction is of the same variety of ametropia and the difference between the two eyes is not very great (1 D. to 2.50 D.) a full correction may be given for each eye. If the difference between the two eyes is very great, or if one eye is hyperopic and the other myopic and the difference in the refraction between the two is great, it is often impossible for the patient to wear the glasses which correct the refractive error for each eye, and in such cases it is necessary to correct the better eye of the two, and to allow a plane glass to be worn in front of the other eye. This is especially the case if a patient does not have binocular vision. It is remarkable, however, and should be borne in mind, that some patients with a very great difference between the refraction of the two eyes will wear lenses correcting the refraction of each quite comfortably, and under all such circumstances it is better to give the correction in order that both eyes may be employed.

Cycloplegics. Inasmuch as the accommodative power is employed to a considerable extent in all patients under forty years of age it is necessary to employ drugs that will temporarily paralyze the ciliary muscle in order that the full refractive error may be determined. They are not so frequently employed after the fortieth year because the accommodation has become somewhat weakened, and in addition because there is a tendency to glaucoma. If a cycloplegic is employed after the fortieth year for determining the refractive error it should be one of short duration. The drugs which are usually employed are the following:

Sulphate of Atropine, in the strength of gr. iv–f℥j, is used when a cycloplegic of *long duration* is desired. This is the case in young children in whom the accommodative power is very great, and also in those cases presenting considerable disturbance of the choroidal coat requiring rest of the eyes. One drop of the solution is instilled into each eye three times a day until the final

test for glasses has been made. The effect of the drug upon the ciliary muscle lasts from ten days to two weeks.

Sulphate of Duboisine, Hydrobromate of Hyoscyamine, and the **Sulphate of Daturine** are employed in solutions of half the strength of atropine, or gr. ij–f℥j. The effect of these drugs upon the ciliary muscle wears off in from five to seven days, and they are employed in the same way as the atropine solution.

Hydrobromate of Scopolamine in the strength of gr. j–f℥j, will paralyze the accommodation within a half hour after two instillations, each having been made a few minutes apart. The effect lasts about four days. The same drug is sometimes employed in a solution as weak as $\frac{1}{10}$ of 1 per cent., several instillations being made at a few minutes' interval.

Hydrobromate of Homatropine is used in the strength of gr. viij–f℥j, and by some surgeons in twice this strength. To produce complete paralysis of the accommodation it is necessary to employ cumulative instillations. Paralysis of the accommodation from the use of this drug wears off more quickly than from any other which we possess. Of the above solution one drop should be instilled into each eye every ten minutes for an hour, and the refraction of the eye tested within the next three-quarters of an hour, or else another drop of the solution should be instilled to continue the effect, which begins to pass off in about an hour after the last instillation. The power of the ciliary muscle has entirely returned in from thirty-six to forty-eight hours.

To *avoid the constitutional effects* from any of this class of drugs it is necessary to instil as few drops as possible, and to make pressure upon the lacrymal duct, or to evert the lacrymal punctum during each instillation. If severe constitutional symptoms should arise from their use, which are most frequently characterized by flushing of the face, sleepiness, unsteady gait and sometimes even delirium, the instillations should be discontinued at once, and small doses of morphine administered to counteract

the effect. The drugs should always be very cautiously employed after the fortieth year, and should not be employed in patients with a tendency to glaucoma.

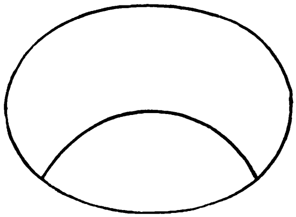
Presbyopia. This is a condition of the eye in which the near-point becomes so far removed as to make continued near work uncomfortable. It is produced principally by a hardening of the nucleus of the lens by which the latter loses part of the ability formerly possessed to change its antero-posterior diameter, and thereby its refractive power. As has been previously stated, the near-point of accommodation gradually recedes from the eye with advancing age, and when that point is reached where the patient is obliged to place his work so far away as to produce discomfort the condition is termed presbyopia. It usually appears in the neighborhood of the fortieth year, sometimes later and sometimes earlier.

Symptoms. The symptoms complained of are inability to hold reading matter or sewing as near to the eye as formerly. There is great difficulty in threading a needle, or reading small print. The work must be placed further from the eye, and the patient is constantly seeking for brighter illumination.

Treatment. The treatment consists in giving the patient that convex spherical lens which will bring his near-point to a satisfactory working distance. If a patient has been previously emmetropic it is necessary for him to employ glasses for near work only. If he has been hyperopic, a lens with an increased focal power will be required for near work. For this reason when hyperopia is corrected in patients in the neighborhood of the fortieth year the near-point of accommodation should always be tested through the correcting lens, and if not sufficiently near should be made so by the addition of a glass in front of that lens which corrects the hyperopia. Two pairs of glasses may then be prescribed, one for distance and one for near, or both may be combined as in *bifocal lenses*, the upper part being for distance, the lower part for near work.

If the patient has been previously myopic in a slight degree, when the age of presbyopia is reached no glasses will be required for near work, as the amount of myopia may be completely neutralized by the amount of presbyopia. If a patient has been wearing concave lenses of moderate strength it will be necessary to reduce the strength for near work and to give either two pairs, or both pairs combined, as in bifocals. In the latter case the lower segment would be a convex spherical lens cemented to the concave spherical lens, thus neutralizing that amount of myopia which would correspond to the amount of presbyopia present.

FIG. 162.



Bifocal glass.

The Fitting of Glasses. In order that the patient may wear glasses with comfort it is necessary that they be properly fitted in front of the eyes. The lenses should be placed as near the eyes as possible, but must not be so close that the cilia will sweep over them or rest upon them. The optical centres must be placed in front of the pupils, and if a pair of glasses is to be worn constantly the upper edges of the lenses should be tilted slightly forward. If two pairs of glasses are employed, one for distance and one for near work, the former should be placed almost horizontally in front of the eyes, and the latter should be placed somewhat lower, and "dipped," that is, the upper edge tilted forward to a greater extent than if the glasses are to be worn constantly, usually about 25°. If the patient suffers much

from headache and is astigmatic it is better to prescribe spectacles; otherwise, nose-glasses, if they can be worn, are usually satisfactory. For certain purposes, as golfing, shooting, billiards, etc., periscopic lenses may be employed, as they produce less distortion of the periphery of the visual field than ordinary lenses.

In those cases requiring glasses for distance and near work bifocal lenses are prescribed, as they can be worn constantly without changing from one pair to another.

In beginning the use of any glasses it should be borne in mind that the eye has to adjust itself to the new conditions; patients are therefore warned that, as a rule, it requires a few weeks to become entirely accustomed to their glasses. Care should always be exercised in going up and down stairs, or in crossing streets for the first few days after beginning the use of new lenses.

CHAPTER XVIII.

AFFECTIONS OF THE OCULAR MUSCLES.

Anatomy and Physiology. The external muscles of the eyeball are the *internal* and *external recti*, the *superior* and *inferior recti*, and the *superior* and *inferior obliques*. All of these muscles, with the exception of the inferior oblique, take their origin from the apex of the orbit in the neighborhood of the optic foramen, the external rectus having a double head, the origin of the second head being from the lower border of the sphenoidal fissure. In their passage forward they are so arranged as to form a cone-shaped covering for the optic nerve and the posterior portion of the eyeball, being joined by the *capsule of Tenon*. The internal rectus is inserted into the sclera about 6 mm. from the corneo-scleral junction by a thin spreading tendon. The external rectus is inserted in a like manner in the outer side of the sclera, about 7 mm. from the corneo-scleral junction. The superior rectus is inserted into the superior portion and the inferior rectus into the inferior portion of the sclera about 7 mm. or 8 mm. back of the corneo-scleral junction. The superior oblique passes to the upper inner angle of the orbit through a tendinous pulley, then outward and backward to the globe below the superior rectus, and is inserted into the sclera a little back of the equator at the upper margin of the external rectus. The inferior oblique arising from the inner angle of the margin of the orbit passes backward and outward beneath the inferior rectus, and is inserted in the sclera somewhat back of the equator and beneath the external rectus.

Tenon's Capsule is practically an orbital lining consisting of two layers, an external and an internal. There

are numerous prolongations of the external layer sent outward along the external ocular muscles, which fasten them together, and which are most marked upon the internal and external recti; in fact, their attachments to these muscles are sometimes known as "*check ligaments.*" The posterior portion of the sclera is surrounded by the internal layer, the two layers thus forming a lymph space, making a socket for the eyeball. The internal layer is also pierced by the tendons of the external ocular muscles.

The Nerve Supply of the ocular muscles is as follows: The superior, inferior, and internal recti and the inferior oblique are supplied with filaments from the *oculomotor nerve.* The superior oblique is supplied by the *fourth* and the external rectus by the *sixth* cranial nerve.

The *actions of the external ocular muscles* produce certain rotations of the eyeball, which for practical purposes may be considered to be around a vertical, horizontal, or oblique axis. The external and internal recti produce the lateral movements of the eye on its horizontal plane; the superior rectus rotates the cornea upward and inward, turning the upper extremity of the vertical meridian toward the nose; the inferior rectus rotates the cornea downward and inward, turning the lower extremity of the vertical meridian toward the nose; the superior oblique rotates the cornea downward and outward, turning the upper extremity of the vertical meridian toward the nose; the inferior oblique rotates the cornea upward and outward, turning the lower extremity of the vertical meridian toward the nose. In producing lateral movements of the eyeball the external and internal recti alone are involved; in upward movements the superior rectus and the inferior oblique are employed; the downward movements are made by the inferior rectus and the superior oblique.

There are also *associated* and *co-ordinated movements.* These are movements which the eyes make together for the accomplishment and continuation of binocular single vision, and are very complex. The movement of conver-

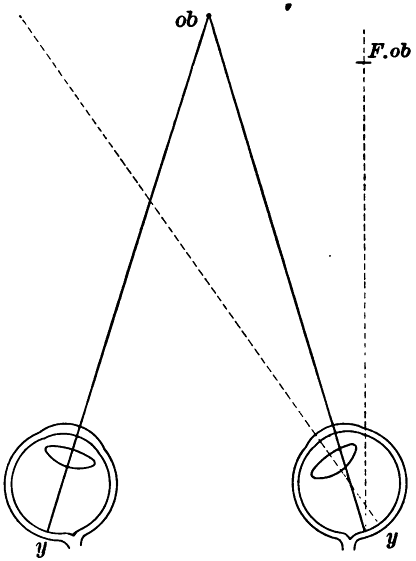
gence is of the greatest importance, and is employed for observing distinctly all objects within infinity. The action of accommodation and certain reactions of the pupil are closely associated with the action of convergence.

The Field of Fixation is a term which has been given to the angular deviation of the eyes which can be produced by the external ocular muscles and which enables the eyes to fix any point in common without producing double vision. Like the field of vision its extent can be determined by the employment of a perimeter, noting the furthest point on the perimetric arc at which the patient can maintain distinct binocular single vision in the various meridians. The limitation of the field of fixation as given by Landolt is as follows: outward, 45°; downward, 50°; inward, 45°; upward, 43°. The extent of the normal field of fixation is of much value in determining muscular defects that may be present.

Binocular Single Vision. To obtain binocular single vision the visual axis of each eye must be directed toward the same point, and the image of the object must fall on a corresponding part of the retina of each eye. These parts are known as *identical points of the retinæ*, and when the images of objects so fall binocular single vision results. The condition is known as *binocular fixation.* Deviation of the visual lines so that the images of objects fall upon parts of the retinæ which are not identical produce *diplopia* or *double vision.* This deviation may be very slight or very pronounced. In those forms in which the deviation is slight the images may be fused by an effort on the part of the muscles. In those forms in which the deviation of the visual lines is very great one image is either disregarded or the patient has double vision. If the latter condition is present and the images are of the same color and sufficiently near each other, an unconscious effort is made on the part of the eye muscles to place the visual lines in the direction necessary for the fusion of the images, and the diplopia is thereby over-

come. When double vision is present the image which belongs to the eye which is looking directly at the object so that it falls upon the macula lutea is known as the *true image*. The image of the deviating eye which is falling upon some other portion of the retina than the macula lutea is known as the *false image*. Images of objects situated to the right of the fixation point fall to

FIG. 163.

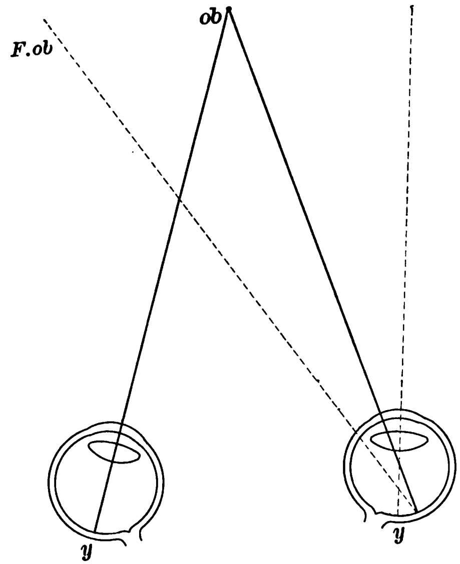


Shows the position of the double images in diplopia from convergent or crossed strabismus. The images are homonymous, or correspond in position to the eyes.

the left side of the macula, and likewise images situated to the left of the fixation point fall to the right side of the macula. Again, images of objects situated above or below the fixation point fall to the opposite side of the macula. The projection of an image, however, or the manner in which we estimate the position of an object is the reverse of the above. Thus, experience teaches us

that objects whose images fall to the right or left of the macula are situated to our left or right respectively, and also that objects whose images fall below or above the macula are situated above or below respectively. In this manner, if we have a deviation of the right eye inward so that diplopia results the true image will be seen with the left eye, which is fixing the object, and the

FIG. 164.



Position of double images in divergent strabismus. The images are crossed.

false image with the right eye, in which the image falls upon some peripheral portion of the retina. There will result, however, *homonymous diplopia* because the false image is on the same side as the eye which deviates, and is, according to the law given above, because the *image falls to the left of the macula and the object is referred to the right* (Fig. 163). If, on the other hand, we have the right eye deviating outward, *heteronymous*, or *crossed*

diplopia, results, the false image being on the side of the fixing eye. This is according to the law given above, the image of the object falling to *the right of the macula lutea, the object necessarily being referred to the left in the field of vision* (Fig. 164).

Varieties of Ocular Deviations. The affections of the ocular muscles resulting in deviation of one or both eyes from the normal position may be classed under three headings, viz.: *paralysis of the ocular muscles,* in which there is a deviation on account of impairment of power in one or more of the muscles; *concomitant squint,* or *strabismus,* in which there is a decided deviation which the patient has no ability to overcome; *heterophoria,* or *muscular insufficiency,* in which there is a latent deviation which is corrected by the effort of the ocular muscles to hold the eyes in position to maintain binocular single vision.

Paralysis of the External Ocular Muscles (Paralytic Strabismus). Paralytic strabismus is a condition in which there is a paralysis of one or more of the muscles of the eyeball and in which we may have the following symptoms:

Symptoms. The first symptom to which the patient's attention is probably directed is *diplopia,* or double vision. The cause of this is evident from the fact that there is a deviation of the visual axis from parallelism in certain portions of the field of fixation. The diplopia is always more or less marked when the patient attempts to look toward the side on which the paralyzed muscle is situated, and may disappear entirely in that half of the field of fixation opposite to the side of the paralyzed muscle.

For the same reason there may be some *inclination of the head from the erect posture,* because by inclining the head toward the side of the paralyzed muscle and looking toward the opposite side the images can oftentimes be fused so that binocular single vision results. In order to obtain this condition the head of the patient is always inclined toward the position of the paralyzed muscle.

There is also *false projection* of the images in the field of vision on account of the situation of the image of the object on the peripheral portion of the retina of the deviating eye and as the result of the greatly increased innervation which is sent along the nerve of the paralyzed muscle in the effort to overcome the defect. On account of this symptom patients suffering with paralysis of the various ocular muscles will frequently knock against people in walking because it is difficult for them to determine the false from the true image.

There is always *limitation of movement of the eyeball* in the direction of the paralyzed muscle. If the eyes are made to fix an object held directly in front, and the object be then moved from side to side, or from above or below, it will be noted that one eye will follow the object in all directions, while the other lags behind when the object is moved toward the side upon which the muscle is paralyzed. In making this test the condition of *paralytic strabismus* will also be observed, a condition which is more or less noticeable in some instances when the patient is looking directly in front, but which increases as the fixing eye is turned toward the paralyzed side. On the contrary, if the eyes are turned in the direction opposite the paralyzed muscle there is no squint.

The deviation of an eye in which there is paralysis of an external muscle is in a direction opposite to the paralyzed muscle, and is known as the *primary deviation.* The deviation of the normal eye while the affected eye fixes an object is known as the *secondary deviation,* and is greater than the primary deviation because it is necessary for the affected eye to have a much greater nerve impulse to stimulate its movement, which results in overstimulation of the muscles of the normal eye and in excessive movement. This is a point which is frequently employed in the differentiation between a paralytic and a concomitant squint, because in a concomitant squint the primary and the secondary deviations are equal.

Vertigo is also observed in some cases of paralysis on account of the confusion which is produced by the diplopia and the false projection of the image.

Method of Testing for Diplopia. The patient is seated in a chair, and in front of one eye is placed a piece of red glass to enable him to differentiate between the two images. He is directed to look at a flame of light from a candle or gas-jet a few metres' distant, and asked whether one or two images of the flame are seen, and their relative positions. The image belonging to each

FIG. 165.

Paralysis of left external rectus. (Dercum.)

eye can be readily ascertained by first covering one, then the other eye, and noting which image disappears. It must be ascertained whether the diplopia is homonymous or crossed, and whether the images are on the same or a different level. In addition, it should be noted whether they are erect or inclined. The flame is now moved from side to side, and upward and downward, and it is noted whether or not the diplopia increases or diminishes in any portion of the field of fixation.

After a paralysis has existed for a long time the symp-

toms are much less characteristic than they are shortly after its appearance. In some cases the false image becomes so suppressed that the diplopia disappears and the opposing muscle sometimes becomes so contracted that the squint is materially increased.

Varieties of Paralysis. Any one of the muscles may be paralyzed alone or in conjunction with some of the others. If a single muscle is paralyzed it produces, as a rule, a characteristic diplopia; if two or more muscles are paralyzed the diplopia is different from that which would characterize either if paralyzed alone. In the following descriptions the "sound side" refers to the unaffected eye, the "paralyzed side" to the affected eye. The following symptoms will be found in paralysis of the different muscles:

External Rectus (Sixth Nerve). According to some authors this muscle is the one which is most frequently paralyzed. It is characterized by limitation of the movement of the eyeball outward and by convergent strabis-

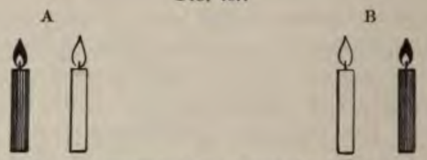
FIG. 166.

A, position of images in paralysis of left external rectus, and B, in paralysis of right external rectus. The false image is drawn in outline, the true image shaded. (de Schweinitz, after Fuchs.)

mus. The diplopia is homonymous, the images on the same plane, the distance between the true and the false image increasing as the object is moved in the direction of the paralyzed muscle. The images are parallel except in the extreme upper and extreme lower portions of the field. The face is turned toward the paralyzed side so that the patient may rid himself of the diplopia.

Internal Rectus. In paralysis of this muscle we have limitation of convergence of the eye and divergent strabismus. The diplopia is crossed and the images are on

FIG. 167.



A, position of images in paralysis of left internal rectus, and B, in paralysis of right internal rectus. (de Schweinitz, after Fuchs.)

the same level and parallel, separating as the object is moved toward the sound side. The face is turned toward the sound side.

FIG. 168.

Paralysis of right internal rectus and dilated pupil. (Dercum.)

Superior Rectus. There is limitation of the movement of the eyeball upward and toward the unaffected eye. There is diplopia in the upper field, which is crossed,

the false image being higher than the true image, and inclined upward toward the sound side. The two images separate as the object is carried upward in the visual field, and the face is directed toward the sound side and upward.

FIG. 169.

A B

A, position of images in paralysis of left superior rectus, and B, in paralysis of right superior rectus. (de Schweinitz, after Fuchs.)

Inferior Rectus. There is limitation of the downward movement of the eyeball and in the direction of the sound side, and the diplopia is in the lower field and crossed. The false image is below the true image and inclined downward toward the paralyzed side, and as the

FIG. 170.

A B

A, position of images in paralysis of left inferior rectus, and B, in paralysis of right inferior rectus. (de Schweinitz, after Fuchs.)

object is moved downward from the median line the two images become more widely separated. The carriage of the head is with the face somewhat downward and toward the sound side with moderate inclination in the direction of the shoulder of the paralyzed side.

Inferior Oblique. There is limitation of movement upward and in the direction of the paralyzed side. The diplopia is homonymous, is in the upper field, the false image being higher than the true image and inclined

FIG. 171.

A, position of images in paralysis of left inferior oblique, and B, in paralysis of right inferior oblique. (de Schweinitz, after Fuchs.)

upward and toward the paralyzed side. As the object is carried upward from the median line the distance between the images increases. The direction of the face is upward toward the paralyzed side and toward the shoulder of the same side.

FIG. 172.

A, position of images in paralysis of left superior oblique, and B, in paralysis of right superior oblique. (de Schweinitz, after Fuchs.)

Superior Oblique (Fourth Nerve). There is limitation of movement downward and in the direction of the paralyzed side. The diplopia is homonymous, is in the lower portion of the visual field, the false image being lower

than the true image, and inclined downward and toward the sound side. The distance between the images increases vertically as the object is carried downward. The direction of the face is downward and toward the paralyzed side and inclined toward the shoulder of the same side.

Paralysis of the Third Nerve (Oculomotor Paralysis). Inasmuch as this nerve supplies the levator palpebræ,

FIG. 173.

Oculomotor paralysis.

the internal, superior, and inferior recti, the inferior oblique, and the ciliary muscle, a complete paralysis presents a typical and characteristic picture. There is complete ptosis, and, upon raising the upper lid by means of the finger, divergent strabismus will be observed. If an attempt is now made to have the eyeball follow the finger in various directions it will be observed that there is limitation of the upward, downward, and inward movements, and because so many of the external muscles

are paralyzed there may be a moderate degree of proptosis. The diplopia is crossed, the false image being somewhat inclined toward the paralyzed side at its upper extremity, and the direction of the face is upward toward the sound side and inclined toward the shoulder of the paralyzed side. If the paralysis is complete there is also moderate dilatation of the pupil, which does not react to light, as well as paralysis of accommodation.

Recurrent oculomotor paralysis is a variety which is sometimes met with and is most frequently seen in young people. It usually begins with marked headache, followed by nausea and vomiting and some swelling of the lids and orbital tissues of the affected side. In a few days these symptoms subside, paralysis of the muscles disappears, and the patient remains well for a longer or shorter period of time, when another attack occurs. After repeated attacks the muscles do not regain their power, and there is present the typical picture of complete oculomotor paralysis, which is accompanied by recurrent attacks of pain.

Occasionally the paralysis affects only certain *associated movements.* There may be *paralysis of convergence,* though each internal rectus performs its normal action when the eyes are turned toward either side. The *lateral movements may be abolished,* though the internal recti still have the power to converge the eyes. There may be *impairment of the vertical movements with the lateral movements preserved.* These conditions are usually due to some lesion of the nerve centres which preside over the movement involved.

Causes of Paralysis. The lesions producing a paralysis of an ocular muscle may affect the nerve supplying the muscle in any portion of its course. Thus, we have central or peripheral lesions, according to whether the lesion is in the cortical centres, the nuclei, or in a more peripheral portion of the nerve fibres. A lesion at the base of the brain produces a *peripheral paralysis,* and a lesion of the nucleus of the nerve produces a *nuclear paralysis.*

If the lesion is situated in the cortical centres we speak of a *cortical paralysis*.

The most frequent causes are syphilis, rheumatism, gout, especially after exposure, menstrual disorders, anæmia, and diphtheria. Paralysis of the ocular muscles also sometimes accompanies disease of the spinal cord. Traumatism is also a cause, and in a few instances the condition is met with congenitally. The lesion is usually pressure upon or inflammation of the nerves, but occasionally it is a degenerative process. The pressure may be produced by a tumor, hemorrhage, inflammatory exudate, as from meningitis or periostitis, or by some vascular change or injury.

Diagnosis of the Affected Muscle. The diagnosis of the paralyzed muscle is made according to *the direction of the limitation of movement*, *the character of the diplopia* and *the portion of the field in which the diplopia is observed.* The following table, suggested by Hotz, is a very convenient compilation of the symptoms for the purpose of diagnosis:

1. Double images are seen only when the patient turns the eyes in a direction requiring the co-operation of the affected muscle; while, when the eye rotations do not call in action the paralytic muscle, there is no diplopia, but single vision.

2. The image which belongs to the eye with the paralyzed muscle is projected in the direction toward which the affected muscle rotates the eye.

3. When the object is moved in the direction of the affected muscle the false image travels further away from the image belonging to the sound eye—that is, the relative distance of the double images increases when the eyes are turned in the direction of the paralyzed muscle.

Homonymous diplopia is always associated with convergence, and crossed diplopia is always associated with divergence.

A.—Lateral diplopia indicates paralysis of internus or externus.

1. Homonymous images indicate paralysis of externus.

Images separating to the right indicate paralysis of right externus; separating to left, paralysis of left externus.

2. Crossed images indicate paralysis of internus. Images sepa-

rating to right indicate paralysis of left internus; separating to left, paralysis of right internus.

B.—Vertical diplopia in the upper field indicates paralysis of superior rectus or inferior oblique.

1. Homonymous images indicate paralysis of inferior oblique.

Image of right eye higher means paralysis of right inferior oblique; if lower, paralysis of left inferior oblique.

2. Crossed images indicate paralysis of superior rectus.

Image of right eye higher means paralysis of right superior rectus; if lower, paralysis of left superior rectus.

C.—Vertical diplopia in lower field indicates paralysis of inferior rectus or superior oblique.

1. Homonymous images indicate paralysis of superior oblique.

Image of right eye lower means paralysis of right superior oblique; if higher, paralysis of left superior oblique.

2. Crossed images indicate paralysis of inferior rectus.

Image of right eye lower means paralysis of right inferior rectus; if higher, paralysis of left inferior rectus.

Occasionally paralysis of the oblique muscles produces crossed diplopia and paralysis of the superior and inferior rectus, homonymous diplopia. When this is the case the diagnosis of the affected muscle must be made from a study of the vertical diplopia.

The differentiation as to whether the lesion is central or peripheral is sometimes very difficult. Paralyses of central origin are frequently associated with other symptoms which indicate cerebral disease, while peripheral paralyses are more likely to be isolated and complete. It is also much more difficult for the patient to diffuse the images in a paralysis of central origin than in a paralysis of peripheral origin.

Prognosis. In the cases produced by syphilis and rheumatism recovery usually follows prompt treatment if the lesion is peripheral. The prognosis for central paralysis is very unfavorable. In some of the cases which are cured relapses may occur If a paralysis continues for a long time without improvement there results a contraction of the antagonizing muscle. The condition extends,

as a rule, over a period of many weeks before a cure can be effected.

Treatment. In those cases in which syphilis can be established as a cause the early administration of mercury and large doses of iodide of potassium produces the best results; in those cases due to rheumatism, salicylate of sodium, or iodide of potassium; and in those cases due to gout some preparation of colchicum should be administered. Somewhat later, strychnine and galvanism may be employed. Mechanical treatment has been suggested by some authors, and consists in producing local anæsthesia of the eye and with a pair of fixation forceps moving the eyeball forcibly in the direction of the paralyzed muscle once or twice a day.

To prevent the annoying diplopia which accompanies these conditions a small shade may be worn over the affected eye, or in those cases of paresis in which the correcting prism which enables the patient to fuse the images is not too heavy it may be worn temporarily and changed from time to time as the paresis improves. If, after a long course of treatment, there remains a permanent condition of diplopia, this may be corrected by combining with the proper glasses, if the patient requires such, that prism which will correct the diplopia, or a tenotomy of the opposite muscle, either alone or with advancement of the affected one, may be employed.

Ophthalmoplegia. This is a term which is used to describe a condition in which all, or nearly all, of the muscles of the eye are paralyzed, and may be either *acute* or *chronic*.

External Ophthalmoplegia is that condition in which most of the external ocular muscles are affected.

Internal Ophthalmoplegia is that condition in which the internal ocular muscles (the iris and ciliary muscle) are affected. If the iris sphincter is alone paralyzed the condition is known as *iridoplegia*. Internal ophthalmoplegia is frequently associated with syphilis, and is usually of nuclear origin. In the early stages paralysis is incom-

plete, and is characterized by ptosis, some limitation of movement of the eyeball in all directions, the limitation of the upward movement being most marked. It may affect both eyes, but more frequently one eye alone is affected.

Total Ophthalmoplegia is that condition in which the iris and ciliary body, as well as the external ocular muscles, are involved. The acute cases are those which come on very rapidly, in which all the ocular muscles are involved, and are usually fatal. The chronic cases are those in which the disease progresses gradually until the various muscles are involved. If the iris and ciliary body are not involved the region of the disease is probably nuclear. The condition has been observed congenitally.

Treatment. Unfortunately, in many of the cases treatment is of little avail. In those cases in which syphilis can be established as a cause the antisyphilitic remedies should be pushed as rapidly as possible.

Affections of the Ciliary Muscle. As described elsewhere, it is on account of the action of the ciliary muscle that the eye is enabled to accommodate itself for near and distant vision. Somewhere in the neighborhood of the fortieth year some loss of elasticity of the lens and an increase of its nucleus bring about that condition which is known as *presbyopia*. *Spasm of the ciliary muscle* is occasionally met with, and when present produces temporary myopia. The most frequent affection, however, is either *partial* or *complete paralysis*. This condition is found in complete paralysis of the oculomotor nerve. It is also observed in diphtheria, when it is usually present without any affection of the pupil. It has also been found to follow fevers, syphilis, and other constitutional conditions. There is also a paralysis of the ciliary muscle, due to traumatism.

Treatment. The treatment of spasm of accommodation is prolonged mydriasis, and for paresis or paralysis of accommodation, the local instillation of eserine or pilocar-

pine, the administration of full doses of strychnine, the employment of the galvanic current, and the removal of the cause.

Concomitant Strabismus or Squint (Heterotropia) is that condition of the eyes in which there is a deviation of the visual axis from parallelism, and in which one eye follows the other throughout all its movements. There is no limitation of the ocular movements in any direction, as will be found in paralytic strabismus.

Symptoms. The fact that the cosmetic appearance of the patient is bad is the symptom which most frequently causes the ophthalmic surgeon to be consulted. A few patients may have observed that the visual acuity was better in one eye than in the other, but this is by no means always the case. Diplopia and altered carriage of the head are absent.

Varieties of Concomitant Strabismus. A *periodic strabismus* is that condition in which the strabismus presents itself at various times. A *permanent strabismus* is that condition of the eyes in which a strabismus is always present. An *alternating strabismus* is that condition in which the patient can fix an object with either eye, the vision of the two eyes being approximately equal. A *unilateral strabismus* is that condition in which the patient always fixes with one eye, the other eye always deviating. A *convergent strabismus* is a strabismus characterized by convergence of the visual axes. A *divergent strabismus* is a strabismus characterized by divergence of the visual axes. A *sursumvergent strabismus* is that condition in which the deviation is upward. A *deorsumvergent strabismus* is that condition in which there is a deviation downward.

Diagnosis. The diagnosis of concomitant strabismus can usually be made by having the patient fix an object, such as a finger, following it first to the right, then to the left, then upward and downward, and noting whether or not one eye follows the other in all directions. If the squint should be paralytic there would be a history

Internal Rectus. In paralysis of this muscle we have limitation of convergence of the eye and divergent strabismus. The diplopia is crossed and the images are on

FIG. 167.

A, position of images in paralysis of left internal rectus, and B, in paralysis of right internal rectus. (de Schweinitz, after Fuchs.)

the same level and parallel, separating as the object is moved toward the sound side. The face is turned toward the sound side.

FIG. 168.

Paralysis of right internal rectus and dilated pupil. (Dercum.)

Superior Rectus. There is limitation of the movement of the eyeball upward and toward the unaffected eye. There is diplopia in the upper field, which is crossed,

the false image being higher than the true image, and inclined upward toward the sound side. The two images separate as the object is carried upward in the visual field, and the face is directed toward the sound side and upward.

FIG. 169.

A B

A, position of images in paralysis of left superior rectus, and B, in paralysis of right superior rectus. (de Schweinitz, after Fuchs.)

Inferior Rectus. There is limitation of the downward movement of the eyeball and in the direction of the sound side, and the diplopia is in the lower field and crossed. The false image is below the true image and inclined downward toward the paralyzed side, and as the

FIG. 170.

A B

A, position of images in paralysis of left inferior rectus, and B, in paralysis of right inferior rectus. (de Schweinitz, after Fuchs.)

object is moved downward from the median line the two images become more widely separated. The carriage of the head is with the face somewhat downward and toward the sound side with moderate inclination in the direction of the shoulder of the paralyzed side.

Inferior Oblique. There is limitation of movement upward and in the direction of the paralyzed side. The diplopia is homonymous, is in the upper field, the false image being higher than the true image and inclined

FIG. 171.

A, position of images in paralysis of left inferior oblique, and B, in paralysis of right inferior oblique. (de Schweinitz, after Fuchs.)

upward and toward the paralyzed side. As the object is carried upward from the median line the distance between the images increases. The direction of the face is upward toward the paralyzed side and toward the shoulder of the same side.

FIG. 172.

A, position of images in paralysis of left superior oblique, and B, in paralysis of right superior oblique. (de Schweinitz, after Fuchs.)

Superior Oblique (Fourth Nerve). There is limitation of movement downward and in the direction of the paralyzed side. The diplopia is homonymous, is in the lower portion of the visual field, the false image being lower

than the true image, and inclined downward and toward the sound side. The distance between the images increases vertically as the object is carried downward. The direction of the face is downward and toward the paralyzed side and inclined toward the shoulder of the same side.

Paralysis of the Third Nerve (Oculomotor Paralysis). Inasmuch as this nerve supplies the levator palpebræ,

FIG. 173.

Oculomotor paralysis.

the internal, superior, and inferior recti, the inferior oblique, and the ciliary muscle, a complete paralysis presents a typical and characteristic picture. There is complete ptosis, and, upon raising the upper lid by means of the finger, divergent strabismus will be observed. If an attempt is now made to have the eyeball follow the finger in various directions it will be observed that there is limitation of the upward, downward, and inward movements, and because so many of the external muscles

one complete image ordinary stereoscopic views may be substituted.

The operative treatment consists of a tenotomy of one or both interni, either alone or with advancement of one or both externi, the amount depending entirely upon the degree of squint and the condition of the opposing muscles. Thus, if an external rectus is much weaker than normal a tenotomy of the internal rectus will not produce so great a result as if the external rectus was of normal strength. Under ordinary conditions in which the opposing muscle is of normal strength a free tenotomy of one internal rectus will usually correct a deviation of 12° to 14°. Unless the amount of deviation is very great it is better to divide one internal rectus at a time, waiting a while before tenotomy of the other internal rectus is performed, because it is difficult to determine the exact after-effect under the use of the glasses. In all operations for convergent strabismus from 3° to 5° of convergence should be left, as there is always a slight tendency to divergence after a period of several months.

Divergent Concomitant Strabismus (Exotropia). In this variety of strabismus there is an outward deviation or a divergence of the visual axis of one eye when looking at an object. As a rule, the condition is not observed in young children, as is the case with convergent concomitant strabismus, but comes on later in life. It is most frequently associated with myopia, and the higher the degree of myopia the greater is the tendency to divergent strabismus. Divergent strabismus may result from amblyopia of one eye, or from deficient vision on account of opacities in the media.

In myopic eyes no accommodative effort is necessary, and inasmuch as accommodation is always associated with convergence in normal eyes there must be a deficient convergent stimulus in myopic eyes, with a corresponding tendency to relax the internal recti muscles. In addition, in myopic eyes the far-point being so near produces in itself a certain amount of convergence, which, together

with the resulting fatigue and the corresponding relaxation, may result ultimately in divergent strabismus. When the squint is first observed it is usually present only when the eyes are being employed in near work; but, as a rule, it progresses so that in a little while it is present at all times. The condition is sometimes met with after too extensive operation for convergent strabismus.

Treatment. The treatment of divergent strabismus consists in the *correction of any existing refractive error* by means of suitable glasses and the *employment of muscular exercises* to develop the strength of the internal recti. If these measures fail a *tenotomy of one or both external recti,* together with *advancement of one or both internal recti,* according to the degree of squint, must be performed. The glasses should be worked out under full paralysis of accommodation, so that any existing astigmatism may be discovered and corrected. The stereoscope may be employed for strengthening the internal recti muscles, or the method described under exophoria may be of service. If operative treatment is required the operation should not be performed before the patient is six or seven years of age, and, as a rule, only one muscle should be operated upon at one sitting. Any remaining amount of divergence may be corrected by a subsequent operation, glasses being constantly worn in the meantime. Very little effect is obtained in division of the external recti except in exceedingly small degrees of divergent strabismus; therefore, in moderate or high degrees of divergent strabismus the external recti are merely divided, so that more effect may be obtained in the advancement of the internal recti.

Sursumvergent Strabismus (Hypertropia) is a deviation of the visual axis of one eye upward, **deorsumvergent strabismus** a deviation of the visual axis of one eye downward, conditions which may accompany a lateral deviation. Either may also be present without any other defect, and may result from traumatism or a paralysis of

one of the vertical muscles. If the correction of the lateral defect, which they most frequently accompany, does not result in the correction of the vertical squint a tenotomy or an advancement of the vertical muscle at fault may be employed.

Tenotomy of an Ocular Muscle. The following description applies to a tenotomy of the right internal rectus :

The instruments required are a speculum (Fig. 105), fixation forceps (Fig. 103), conjunctival forceps (Fig. 179), a pair of slightly curved blunt scissors (Fig. 176), a strabismus hook (Fig. 177), needle holder (Fig. 178),

FIG. 176.

Tenotomy scissors.

FIG. 177.

Strabismus hook.

FIG. 178.

Needle holder.

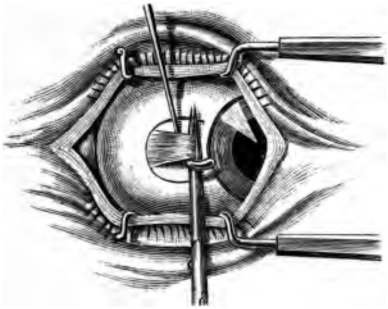
FIG. 179.

Conjunctival forceps.

needles, and fine silk. The patient may be lying upon a table or may occupy a half-reclining position in a chair. The operator may stand in front or behind, as he prefers, though the latter position is the more convenient. The following methods are employed by different surgeons:

The Subconjunctival Method. Local anæsthesia may be employed except in young children, when general anæsthesia is necessary. The speculum having been introduced between the lids, the conjunctiva lying over the lowest portion of the tendinous insertion of the muscle is seized with the fixation forceps and divided with the

FIG. 180.



Tenotomy of an ocular muscle.

blunt scissors. The subconjunctival tissue is next picked up and divided, or both may have been divided with the first cut. A strabismus hook is now inserted into the wound with the point directed backward, and by turning the handle the hook is passed around the tendon, care being taken to get all of the muscle fibres upon the hook. The hook now being transferred to the left hand, the scissors held in the right hand are introduced into the wound and the tendon divided by small cuts as near the sclera as possible. After this has been done the hook is again introduced into the wound and drawn forward above and below to ascertain whether any muscle fibres have been left undivided. If any are found the scissors

are re-introduced and they are divided. If the tenotomy has been complete the hook can be drawn forward beneath the conjunctiva almost to the corneal margin. A vertical suture to close the conjunctival opening may be employed if desired, though it is unnecessary.

The Open Method. The same instruments that were employed in the subconjunctival method are also required for the open method. The conjunctiva is seized immediately over the insertion of the muscle and opened by one or two snips of the scissors; the capsule of Tenon is next opened in the same manner. The strabismus hook is now introduced, and after passing around the tendon the latter is drawn forward into the wound and divided by the scissors as near the sclera as possible. The conjunctival opening is closed with one or two sutures.

Panas' Operation. On the theory that all non-paralytic squints are concomitant and are divided between the two eyes, and because in other tenotomies better results are obtained by stretching the muscles prior to performing the tenotomy, Panas has introduced the operation which bears his name. In this operation no account is taken of the degree of squint, and the operation is always performed on both eyes alike. The same instruments are required as those described under the preceding operations. The speculum having been introduced and the conjunctiva and subconjunctival tissue divided over the insertion of the tendon, the strabismus hook is passed into the wound until it lies beneath the tendinous insertion of the muscle. By a gradual stretching movement the eye is now drawn to the opposite side, by means of the hook beneath the tendon, until the cornea entirely disappears beneath the canthus, after which the tendon is divided in the usual manner. A similar procedure is adopted with the muscle of the opposite eye, after which the conjunctival wounds may be closed by one or two vertical sutures.

After-treatment of Strabismus Operations. During the performance of an operation the amount of the effect

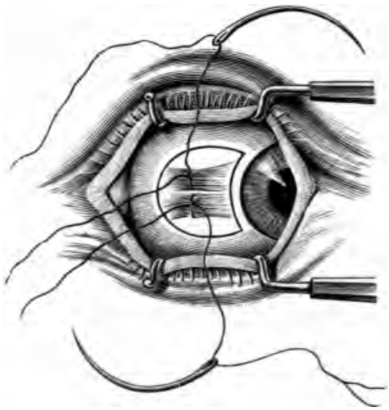
obtained can be measured, from time to time, by noting the position of the corneal images of a candle held one metre from the patient. If the effect obtained is too great the tendon should be picked up and re-attached by two strong sutures. If the effect should not be sufficient, a free division of the capsule of Tenon above and below will increase it. The effect may also be increased by rotating the eyeball in the direction opposite to the muscle which has been divided, and holding it in this position by means of a suture. Inasmuch as there is a tendency to divergence, a small amount of convergence should be left after an operation for convergent strabismus; likewise a small amount of convergence should remain after operations for divergent strabismus. In other words, a convergent concomitant strabismus should be slightly under-corrected, and a concomitant divergent strabismus should be slightly over-corrected.

If the patient can be controlled, and the surroundings are such that infection is not likely to take place, it is better not to bandage the eyes and to permit the patient to wear his correcting glasses from the time of the operation. If, however, the conditions are such that the eyes cannot remain unbandaged both eyes should be covered for a few days. No attempt should be made to use the eyes for near work for a few weeks after the operation is performed, and if, as an after-result, in convergent strabismus there should be a tendency to divergence the glasses may be left off for a while.

Advancement of an Ocular Muscle. The instruments required are the same as those employed in the operation of tenotomy. Local anæsthesia may be used, but general anæsthesia is necessary, as a rule, because the operation is much more painful than a tenotomy. The speculum having been introduced, the conjunctiva and Tenon's capsule are divided immediately over the insertion of the tendon, the opening being as wide as the tendon. That portion of the conjunctiva lying between the opening thus made and the cornea is dissected up

with the scissors. The portion of the muscle which it is desired to advance having been freed from its attachment, a strabismus hook is introduced beneath the tendon and brought forward to its insertion. A curved needle, armed with a silk suture, is now introduced beneath the upper margin at the point it is desired to advance, passed through the middle of the tendon and tied, the needle and thread being left in position. A similar suture is passed through the tendon from beneath the lower margin and tied. The tendon is now divided with the scissors at its

FIG. 181.



Advancement of an ocular muscle.

insertion. The sutures are then passed in the direction of the muscle through the conjunctival and episcleral tissues at the margin of the cornea and each tied with its own end, when by drawing the sutures more or less taut a large or small effect is obtained. The conjunctival suture is now introduced as the last step in the operation. Both eyes should remain unbandaged under proper conditions, or both should be bandaged for several days. The sutures are usually not removed for a week or ten days, unless it is desired to reduce the effect of the operation.

Shortening Operation. Occasionally, instead of dividing the tendon at its insertion into the sclera and advancing it, a *shortening operation* is perfomed in which a catgut suture is so inserted into the muscle as to form a loop of the latter sufficiently large to shorten the muscle as much as is desired.

Heterophoria or Latent Strabismus. Heterophoria, or insufficiency of the ocular muscles, is that condition in which there is a *tendency* of the visual axes to deviate from parallelism, but in which there is no actual deviation except under certain conditions. So long as the stimulus for binocular single vision is maintained there is no actual squint, but if this stimulus is removed there results a slight deviation with diplopia. The condition is a disturbance of the normal balance of the ocular muscles, and differs from concomitant squint only in degree.

Causes. One of the most frequent causes of heterophoria is a refractive error, and this is especially so if it is accompanied by some disturbance of the relation between accommodation and convergence. General weakness of the muscles, which may be congenital in origin or due to various diseases or diatheses, is another very potent cause. Other causes are muscular spasm or some disturbance of innervation.

Symptoms. If the degree of heterophoria is slight it may produce no symptoms or annoyance to the patient. If it is marked there may be headache, pain in the eyeballs, blurred vision, especially in the performance of near work, slight vertigo, and at times diplopia. These symptoms are usually aggravated upon continued employment of the eyes for close work. In some instances there may be serious reflex disturbances in other portions of the body.

Varieties. The following nomenclature suggested by Dr. Geroge T. Stevens is generally adopted in describing these conditions:

Orthophoria, a tendency of the visual axes to parallelism.

Heterophoria, a tendency of the visual axes from parallelism.

Esophoria, a tendency of the visual axes to converge.

Exophoria, a tendency of the visual axes to diverge.

Hyperphoria, a tendency of one visual axis to deviate upward. It is customary to speak of *right hyperphoria* or *left hyperphoria,* according to whether the visual axis of the left eye or right eye tends to deviate upward.

Hyperexophoria and *hyperesophoria* represent a combination of hyperphoria with exophoria or esophoria.

Diagnosis of Heterophoria. *Fixation Test.* If a finger be approached within a few inches of the eyes and the patient directed to fix constantly the tip of the finger with both eyes, a rough test of the balance of the external ocular muscles may be obtained. If one of the eyes deviates outward before the finger is approached to a point within three and one-half inches distant there will be exophoria.

Cover Test. The patient is directed to fix constantly with both eyes an object six metres distant. Each eye is now alternately covered with a card, and it is noted whether either eye changes its position at the moment of uncovering. If under the cover one eye deviates inward or outward, and as soon as it is uncovered again fixes the object, there is present esophoria or exophoria. The same test may be made for an object held 25 cm. from the eye.

Diplopia Test. A more accurate method for measuring the amount of deviation is the *diplopia test,* which may be made in several ways:

The patient is directed to fix constantly a flame of light from a small gas-jet or candle, at a distance of 6 metres, and on a level with his eyes. A prism sufficiently strong to produce diplopia (7° or 8°) is placed with its base down in front of the right eye. This prism may be held by the patient, but a more convenient method is to place it in the trial frame. Vertical diplopia is now present, the upper image belonging to the right eye. If

the two images are in a vertical line, one directly over the other, there is no tendency to divergence or convergence. If the images are, however, not in a vertical line, the upper being somewhat to the right, there is a tendency to convergence, or *esophoria.* If the upper image stands to the left there is a tendency to divergence, or *exophoria.* The amount of esophoria or exophoria present is measured by placing a prism, with its base out or in, in front of the left eye, which is sufficiently strong to bring the two images on a vertical line. A red glass may be used in front of one eye to enable the patient to distinguish more readily the relative positions of the images.

To employ the same test for the measurement of *hyperphoria,* lateral diplopia must be obtained by placing a prism sufficiently strong (8° or 10°) with the base toward the nose in front of the right eye. If the images are on the same level horizontally there is no upward tendency, and, therefore, no hyperphoria. If the right image is higher than the left the visual axis of the right eye has a tendency downward, and there is a left hyperphoria, which may be corrected by placing a prism in front of the left eye with its base down sufficiently strong to place the images on a horizontal level. It should be borne in mind that the hyperphoric eye is the one which observes the lower image.

The same test may be made *during accommodative effort.* A card having upon it a large dot through which a fine line is drawn, is a test which was employed by von Graefe. The patient is directed to observe this dot and line held vertically at a distance of 33 cm. from the eyes, when diplopia is produced by placing a 10° or 15° prism, base up or down, in front of the right eye. If one continuous line with two dots upon it is observed by the patient there is no tendency to a lateral deviation. If, however, the patient observes two separate lines with a dot upon each, a prism base in or out in front of the left eye, which will cause the two lines to join vertically, will measure the amount of lateral deviation.

Rod Test. Inasmuch as it is sometimes difficult for patients to make correct observations as to whether the two images are on a vertical or horizontal level, the use of the *Maddox rod* is a most convenient test. The Maddox rod (Fig. 182) is a short piece of glass rod placed behind a stenopæic slit and mounted in a cell similar to the test lenses. Sometimes a number of rods are placed side by side so that a longer line of light may be produced. The rod may be made of white glass or of colored glass. If the rod is placed horizontally in front of the right eye and the patient directed to look at a

FIG. 182.

Maddox rod.

flame of light six metres distant, he will observe not only the flame of light, but a perpendicular streak of light. If this streak of light passes directly through the flame (A) there is no tendency to a lateral deviation of the two eyes. If it passes to the right of the flame (C) there is a tendency of the visual axes to deviate inward, or esophoria; if it passes to the left of the flame (B) there is a tendency of the visual axes to deviate outward, or exophoria; and the amount of deviation may be measured by placing that prism, base out or in, in front of the left eye which will cause the streak of light to pass vertically through the flame.

If the Maddox rod is now rotated so that it appears vertically in front of the right eye the patient will ob-

serve the flame and a horizontal streak of light. If the streak of light passes through the flame (A) there is no tendency to a vertical deviation. If, however, the streak of light passes above (B) or below (C) the flame there is a left or right hyperphoria (the hyperphoric eye being

FIG. 183.

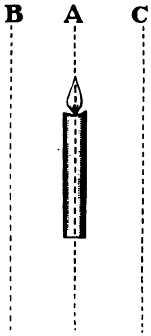


FIG. 184.

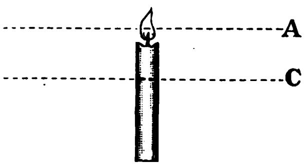


FIG. 183.—Rod in front of right eye. A, position of streak of light in lateral orthophoria; B, in exophoria; C, in esophoria.

FIG. 184.—Rod in front of right eye. A, position of streak of light in vertical orthophoria; B, in left hyperphoria; C, in right hyperphoria.

the one with the lower image), and the degree of hyperphoria may be measured by placing that prism in front of the left eye, with its base down or up, which is sufficiently strong to cause the streak of light to pass directly through the flame.

A very strong convex cylinder may be employed for the same purpose in testing for heterophoria.

Prism Strength of the Muscles. It is also important to know the *prism strength* of the various muscles. The *adducting* or *prism-converging power* is ascertained by finding the strongest prism which can be placed in front of one eye with its *base outward*, the patient maintaining binocular single vision.

The *abducting* or *prism-diverging power* may be ascertained by finding the strongest prism placed in front of

one eye with its *base in* with which the patient can maintain binocular single vision.

The *sursumducting power* is ascertained by finding the strongest prism which can be placed with its *base down*, the patient maintaining binocular single vision. The prism strength of the various muscles must necessarily differ according to circumstances. Approximately the adducting power is 15° to 35°, but can be rapidly increased; the abducting power is from 5° to 8°, the ratio between the two being about 3 or 4 to 1. The sursumducting power is ordinarily not more than 2° to 4°, though in certain instances it may be higher.

The Reimold optometer, an instrument combining the Stevens phorometer, Risley rotary prism, and Maddox rod, furnishes an excellent means for ascertaining the conditions of the external ocular muscles by the tests just described with the least expenditure of time.

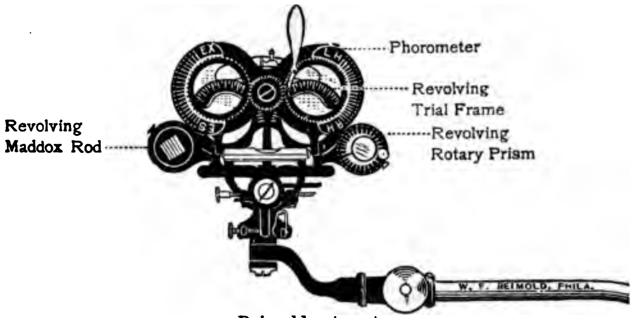
Treatment of Heterophoria. In most individuals there is a slight tendency to heterophoria, and this condition should not be taken into consideration unless it is producing annoying symptoms. Inasmuch as many of the cases of heterophoria are due to uncorrected refractive errors, the correction of the latter should be the beginning of any course of treatment. After the correction of any existing refractive error and the constant wearing of the glasses heterophoric symptoms frequently disappear. In hyperopia with esophoria the full correction of the refractive error should be worn; in hyperopia with exophoria it is sometimes advisable to prescribe only a partial correction in order that accommodation and convergence may be employed. In myopia with exophoria a full correction of the refractive error is necessary.

In all cases of insufficiency of the ocular muscles any existing diathesis must be removed, and tonics which will give tone to the muscles must be employed. For the latter purpose tincture of nux vomica in ascending doses, or strychnine, is of benefit; and, as de Schweinitz

has pointed out, large doses of tincture of hyoscyamine are of use in cases of spasmodic insufficiency.

Prism exercises may be employed and are of much service in exophoria, but of little service in the other varieties of heterophoria. The following is one of the many methods which have been suggested by different surgeons: A prism is placed in front of one eye with its base out sufficiently strong to make the patient see double when looking at a small flame six metres distant. A candle flame held a few inches from the eye will now enable the patient to see singly, and this flame is carried across the room to a point six metres distant, the patient

FIG. 185.



Reimold optometer.

constantly fixing his vision upon it. The strength of the prism is gradually increased as the patient overcomes the diplopia, and in this way the prism-converging power may be rapidly increased in amount, and the symptoms produced by weak adduction relieved.

If the condition is such that it cannot be relieved by exercise, prisms are sometimes prescribed to be worn with the correcting glasses. In lateral insufficiencies it is usual to prescribe about half the amount of the actual deviation if this prism is not too heavy to be worn by the patient, and the amount of the correction is divided between the two eyes. In exophoria the bases of the

prisms must be worn toward the nose, and in esophoria toward the temples, and in hyperphoria up or down. In hyperphoria the amount of deviation is usually small, and the full correction of the defect can be worn, sometimes with great comfort to the patient. The constant wearing of prisms, however, is very much like the use of a crutch; they may be employed for temporary use, but their use for a long period of time is apt to increase the defect. An effect similar to the wearing of a prism may be obtained by decentring the lenses worn for the correction of any existing refractive error.

If the various measures which have just been described fail to relieve the symptoms of heterophoria, operative measures may have to be adopted. An operation, however, should only be performed as a last resort after all other methods have been exhausted. The operations are *partial* or *complete tenotomy*, according to the amount of the defect, *partial advancement*, or *shortening* a muscle. The various operations to be performed depend upon whether the heterophoria is produced by one muscle being too *strong*, or its opponent too *weak;* in the former instance a tenotomy, in the latter instance an advancement, or a shortening operation, being performed.

A *partial tenotomy* is performed by making a small opening into the conjunctiva over the insertion of the tendon, and dividing the central portion of the tendon. This incision may be extended from both borders of the muscle in order to increase the defect, if desired. After each portion of the operation the heterophoria should be measured and the result noted.

Nystagmus is that condition of the eyes in which there are rapid movements in certain directions. *Lateral nystagmus* is a term which is used to describe the lateral movements of the eyeball; *vertical nystagmus* is the term employed to describe vertical movements of the eyeball; and *rotary nystagmus* is that condition in which the eyeball rotates to a certain extent at the same time that the lateral or vertical movements are being made. As a

rule, both eyes are affected, and the condition may be exaggerated by use of the eyes. It is sometimes congenital, is frequently associated with poor visual acuity, but is also found at times in connection with central nervous disease. *Miners' nystagmus* is that variety which is found in miners who are obliged to work in poor light. This variety seems to cause an apparent movement of the objects observed, accompanied by vertigo.

Treatment. The treatment consists in the proper correction of any existing refractive error and a change of occupation, if this has anything to do with the condition. In most cases, however, very little improvement can be made.

CHAPTER XIX.

GENERAL PREPARATION FOR OPERATIONS UPON THE EYE. OCULAR THERAPEUTICS.

It is necessary to employ the general principles of aseptic and antiseptic surgery in operations upon the eye and the surrounding parts, as well as in operations upon other portions of the body, with the exception of the strong antiseptic solutions employed elsewhere, which are here, as a rule, prohibited. It has been generally shown that it is impossible to remove all of the micro-organisms from the conjunctival cul-de-sacs and from the lid margins except by the employment of germicidal solutions sufficiently strong to produce injury to the parts; the object to be attained, therefore, is the mechanical removal of as many bacteria as possible, and the diminution of the vitality of those remaining.

Preparation of the Patient. Before attempting any operative procedure upon the eye, especially such as involves the eyeball, it is important that the patient's general health be placed in the best possible condition. In emergency cases which demand immediate operation this cannot be done, but in cases which can be postponed the surgeon will be rewarded by attending to any details that will improve the patient's physical or mental condition. Such conditions as diabetes and albuminuria may be improved by means of proper diet and a course of medicinal treatment. If any acute pulmonary disease is present the operation should be postponed until after it has subsided. If there is any chronic pulmonary disease it is especially necessary to allay the cough during and immediately following any operation involving the opening of the eyeball. For this purpose heroine in the strength of $\frac{1}{16}$ to $\frac{1}{12}$ grain frequently repeated is of much

value. A hypodermic injection of morphine immediately after an operation will temporarily relieve the cough and secure rest until the lips of the wound have had an opportunity to unite.

It is absolutely important that there be no suppurative disease of the conjunctiva or lacrymal sac in those cases requiring the opening of the eyeball. Such conditions must be treated as long as it is necessary to rid the patient of them, both by topical applications and intranasal medication, and for a persistent dacryocystitis resisting prolonged treatment it is sometimes advisable to close the lacrymal punctum by means of the actual cautery.

On the day preceding the operation the patient should be given a warm bath, which should include a shampoo of the head and beard. A mild laxative should be administered at bedtime to be followed next morning by an enema, which will place the patient's bowels in the best condition for rest and quiet after the operation.

Preparation of the Region of Operation. A few hours preceding the operation the skin of the eyelids and surrounding parts is thoroughly washed with soap and water, followed by a rubbing with alcohol and then by a solution of bichloride of mercury of the strength of 1 : 5000. The brows and ciliary margins must be given particular attention, and at the same time the conjunctiva must not be irritated by permitting the various substances to come in contact with it. The conjunctival cul-de-sac is next freely irrigated with a solution of boric acid or with a solution of bichloride of mercury 1 : 5000. The eye and surrounding parts are then covered with a sterile dressing until the surgeon is ready to proceed with the operation. A most useful procedure, as advocated by Lippincott, is to spray the nares three or four times a day for a couple of days preceding any operation upon the eyeball with a solution of permanganate of potassium 1 : 2000.

Just before the surgeon is ready to proceed with the

operation the dressing is removed and the conjunctiva again flushed with the boric acid or bichloride of mercury solution, and the lid everted and its conjunctival surface gently wiped with a pledget of absorbent cotton moistened in the same solution. It is also advisable to wipe that portion of the surface of the cornea in which the puncture is to be made in all operations in which the eyeball is to be entered. In office operations when the surgeon is ready to proceed at once after the preparation of the patient the temporary dressing is dispensed with.

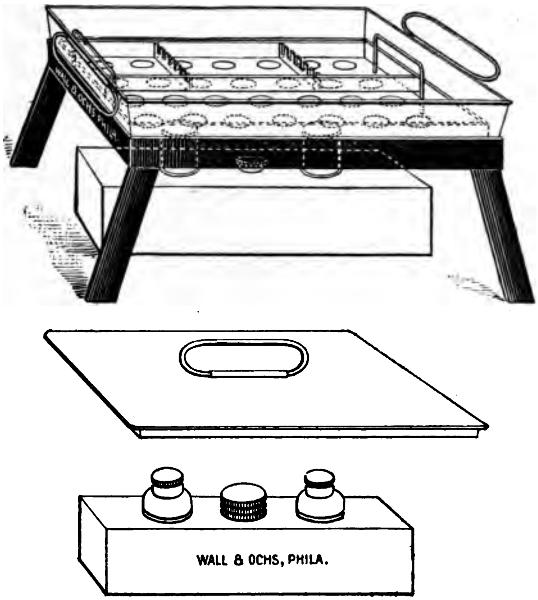
FIG. 186.

Bottle and irrigator for boric acid solution.

Preparation of the Surgeon and Assistants. The hands of the surgeon and all assisting him in the operation must be thoroughly cleansed with soap and warm water, particular attention being given to the nails. They are next immersed in alcohol for a moment, and then dipped in a solution of bichloride of mercury 1 : 1000, *after which nothing should be touched that has not been previously rendered sterile.* It is well to acquaint the assistant with the details of the proposed operation and the order in which the instruments will probably be required. The assistant should also be instructed as to the method of

removing pressure from the eyeball by elevating the speculum and the probable procedures in case of complications. The nurse must be prepared to render any assistance required, and no one concerned in an operation in which the eyeball is to be opened should have handled any septic cases for some hours before the performance of the operation.

FIG. 187.



Author's portable sterilizer.

Preparation of Instruments, Sponges, Sutures, Ligatures, and Dressings. **Instruments.** The various instruments to be employed in an operation upon the eyeball, with the exception of cutting instruments with very fine points, should be thoroughly scrubbed with soap and warm water. It is always best to do this immediately after as well as immediately before each operation. They are then placed in a steam sterilizer for ten minutes, or

else boiled in a 1 per cent. solution of carbonate of soda for three to five minutes. They are transferred from the sterilizer to a dish containing absolute alcohol, where they remain until the surgeon is ready to proceed with the operation, when they are placed in sterile water in order to remove the alcohol, which is irritating to the eye.

The delicate cutting instruments required in eye operations cannot be treated in the same manner as the coarser instruments without destroying to a considerable extent their cutting qualities. They should be first wiped with sterile cotton moistened in absolute alcohol, and then wrapped with sterile cotton and dipped for a moment in boiling water, after which they may be placed in absolute alcohol or wrapped in sterile cotton until required. Just before using they should be again dipped for an instant in boiling water.

Many other methods are employed to obtain the same results by different surgeons. Some do not use absolute alcohol, but place the instruments after boiling in a 3 per cent. solution of carbolic acid or a 1 : 1000 formalin solution. Others transfer them at once to sterile water, while others produce sterilization by means of formaldehyde gas liberated in a specially devised sterilizer.

Before beginning any operation the instruments should be arranged in the order in which they will probably be required, so that they may be obtained quickly in case of complication.

Sponges. Ordinary sponges prepared by the methods in common use in general surgery may be employed, but small pieces of sterile gauze or sterile absorbent cotton are preferable. In deep-seated operations in the orbit it is well to wrap pieces of gauze or cotton on the ends of sterile sticks or probes so that sponging may be performed without obscuring the field of operation.

Sutures and Ligatures. These may be of catgut or fine silk, and are prepared in the same manner as for use in general surgery. Either white or black silk may be employed, but the latter is preferable if it is to remain in

position for some time, as it is more readily located for removal.

Dressings. The dressings to be placed upon the eye after an operation differ somewhat according to the nature of the operation. In extensive plastic operations about the lids the same dressings are employed as in general surgery, viz., a protective, pads of sterile gauze, absorbent cotton, and a roller bandage. In most ophthalmic operations, however, the dressing consists of a few layers of sterile gauze $2\frac{1}{2}$ inches in diameter, which

FIG. 188.

Ring's eye mask.

may be placed over the eye in a dry state, or moistened with a weak solution of bichloride of mercury, or a solution of boric acid. This is covered with a small amount of absorbent cotton to fill in the depression made by the orbital ridge and the nose, and both are fastened in position by means of a few strips of isinglass or zinc plaster, or the figure-eight bandage may be applied.

After iridectomies or cataract extractions both eyes should be dressed, and a protective mask employed, the latter being of use not only in protection of the eye from

accidental injury, but in excluding the light. In place of the extensive figure-eight bandage, in some cases a *modified Liebreich bandage*, which is knit of black zephyr and fastened in position by a tape at each end, may be employed.

FIG. 189.

Modified Liebreich bandage.

A *ring dressing* which is sometimes employed after skin grafting consists in surrounding the field of operation with a ring of sterile gauze which is of sufficient thickness to prevent the dressings from coming in contact with the parts.

Eye-shades are also sometimes employed after the dressings have been discarded. *Buller's shield* (Fig. 34) is employed in certain cases as a protection dressing.

FIG. 190.

Eye-shade.

General Anæsthesia. In most of the operations performed upon the eye local anæsthesia is sufficient, but in a few general anæsthesia is required. Ether is preferable to chloroform for this purpose, except in patients affected with chronic bronchial affections. Bromide of ethyl is sometimes employed, but does not possess any advantage

over ether or chloroform. Nitrous oxide gas may be used in very short operations.

Local Anæsthesia. Local anæsthesia in operations upon the eye is most frequently produced by means of *hydrochlorate of cocaine*, which is ordinarily employed in solutions of 2 to 4 per cent. Inasmuch as it produces some softening of the corneal epithelium the eyelid should remain closed after its instillation. For superficial operations one instillation is usually all that is required, but in deeper operations, as iridectomy and extraction of cataract, three instillations should be employed at five-minute intervals, and the operation begun fifteen minutes after the first instillation.

Hydrochlorate of eucaine "*A*" and *hydrochlorate of eucaine* "*B*" are sometimes used as local anæsthetics, though the first is not so frequently employed as formerly, as the latter is less irritating and less toxic.

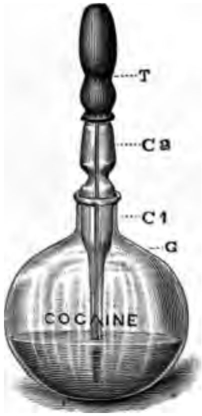
Tropacocaine in 3 per cent. solutions is also employed by some surgeons, who claim more rapid anæsthesia than with other drugs of this class.

Holocaine, one of the more recent local anæsthetics, is used in solutions of 1 to 2 per cent. strength. It is not supposed to affect the corneal epithelium, produce mydriasis, or impair the accommodation. It is also stated that it produces anæsthesia more quickly than cocaine. Some surgeons prefer it in all operations in which local anæsthesia is employed. Inasmuch as it possesses some bactericidal action and does not affect the corneal epithelium it is to be given the preference in corneal affections in which a local anæsthetic is required.

As most of the anæsthetic solutions, as well as other alkaloidal solutions employed in the eye, present excellent media for the growth of various fungi they should be thoroughly sterilized before use. This may be accomplished by boiling or by preparing the solution in some antiseptic medium, as bichloride of mercury 1 : 5000, or trikresol 1 : 1000 (E. A. de Schweinitz). A solution of boric acid, 10 grains to the ounce, will not prevent the

growth of fungi, but will prolong somewhat the period prior to their appearance. A Stroschein flask is very convenient for the sterilization of these solutions.

FIG. 191.



Stroschein's flask.

Infiltration Anæsthesia. This method of inducing local anæsthesia consists of the *intra*cutaneous injection of the following solution :

℞.—Hydrochlorate of cocaine . . .	gr. j.
Chloride of sodium	gr. j.
Distilled water	℥j.—M.

Sterilize.

This method was suggested by Schleich, and with a hypodermic syringe a drop or two of the solution is injected *into* the skin, producing a small wheal. Another injection is made at the edge of the first wheal, and the procedure is repeated until anæsthesia has been produced in the desired area. There is so much looseness of the tissues and vascularity of the lids, however, that the method is very little used in ophthalmic practice.

Position of Patient and Operator. Position of Patient. This is, perhaps, more a matter of convenience to the

surgeon than of importance to the patient, except in rare instances. As a rule, most operators prefer to have the patient in a reclining posture, and in all operations for cataract to have him in the same bed in which he is to remain during convalescence. Other surgeons employ an operating chair, the patient remaining in a half-sitting, half-reclining posture during the operation.

Ordinarily the patient should be reclining upon his back, his head resting upon one or two hard pillows, and the face directed upward. The eyes should be slightly

FIG. 192.

Knapp's operating chair.

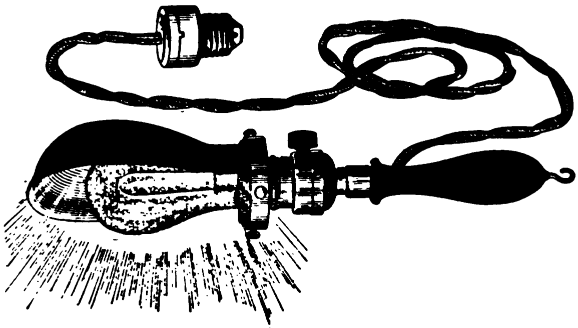
lower than the level of the forearm of the surgeon when it is extended a little below the horizontal, as this position is least tiresome to the operator.

The Position of the Operator may be either behind or beside and somewhat in front of the patient. If he is ambidextrous he may stand behind in all operations; if not, it will be necessary for him to stand behind the patient in certain operations upon the right eye, and by the side of the patient in the same operations upon the left eye. To attain experience in operating with each hand the

various operative procedures should be practised upon the eyes of animals, pigs' eyes being the best, as they can always be obtained in sufficient quantities.

Illumination. In most operations upon the eye it is absolutely necessary that the illumination be of the best. It may be either daylight or artificial light from an Argand burner or electric bulb. It should come from the side of the patient to be operated upon, and be as bright as possible barring sunlight. That obtained from a small space is the most satisfactory because annoying reflections are thereby avoided. The illuminating power

FIG. 193.



Hand lamp and reflector for electric current.

of artificial light may be increased by having it focused upon the eye by means of a condensing lens.

It is also of the greatest importance that the operator has good sight, so that if he has any refractive error it is necessary that it be corrected to give him distinct near vision. Various magnifying glasses have been suggested from time to time by different surgeons to improve the vision in operative work even in those who have no refractive error, but these do not seem to possess any advantage over the ordinary correcting lenses.

Time of Performance. Operations upon the eye may be performed at any hour of the day or night, and at

any season of the year. The latter influences result in those operations necessitating more or less confinement only in so far as it may increase the debilitated condition of the patient. Exceedingly stout persons should, therefore, not be operated upon in extremely hot weather, and persons affected with nephritic or pulmonary disease should not be operated upon in extremely cold weather. In most cases it is probably better to operate, if possible, early in the morning while fresh, and before other cases have been handled. In operations for cataract, however, some surgeons recommend the operation to be performed in the afternoon, so that the few hours of smarting which usually follow will be succeeded by sleep and rest during the night, which are so necessary for the early union of the corneal wound.

After-treatment. There are no hard-and-fast rules which can be given concerning the after-treatment of operative cases which will be applicable to all alike. Each case will require some special treatment, according to the operation performed. In general, however, the patient should be permitted to lie in one position no longer than is absolutely necessary, for fear of hypostatic congestion of the lungs. If severe hemorrhage has followed any form of operation the head of the patient should be kept high by means of several pillows, and the head of the bed also elevated. If there is much pain following any operative procedure, or the patient is restless, an anodyne should be administered. Sleep and rest can almost always be obtained, if pain is not present, by a dose of 15 grains of trional. If there is much pain, however, a hypodermic injection of morphine should be administered. Patients accustomed to the regular use of spirituous liquors should not have these entirely withdrawn, but they should be permitted in moderation. In operations which require the opening of the eyeball it is better to keep the patient on soft diet for forty-eight hours in order that the corneal wound may not be forced open by chewing movements. As a rule, the dressings

should be changed once a day and the eye carefully inspected and cleansed with warm boric acid solution or with warm physiological salt solution until they are no longer required. When the bandage is removed the eyes must be accustomed gradually to light, a pair of smoked glasses and an eye-shade being worn for a while. If the bowels do not move spontaneously in three or four days after an operation has been performed a laxative should be administered, and in those operations in which the eyeball has been opened the patient must be guarded against straining at stool.

OCULAR THERAPEUTICS.

Antiseptic and Cleansing Solutions. Solutions of many substances are employed for irrigating the eyes; those in most frequent use are the following:

℞.—Bichloride of mercury	gr. ¾–1½.
Chloride of sodium	gr. v.
Distilled water	Oj.—M.

℞.—Iodide of mercury	gr. 1/7.
Absolute alcohol	fʒj.
Distilled water	f℥vj.—M.
Sig.—Panas' solution.	

℞.—Cyanide of mercury	gr. j.
Distilled water	f℥x.—M.

℞.—Boric acid	gr. x.
Distilled water	f℥j.—M.

℞.—Formaldehyde	gtt. ij
Distilled water	Oj.—M.

℞.—Chloride of sodium	gr. j.
Distilled water	f℥ij.—M.

℞.—Permanganate of potassium	gr. iv.
Distilled water	Oj.—M.

℞.—Carbonate of sodium	gr. viij.-xij.
Distilled water	f℥j.—M.

℞.—Biborate of sodium . . . . . gr. x–xx.
Distilled water . . . . . . f℥j.—M.

℞.—Chlorate of potassium . . . . . gr. x–xv.
Distilled water . . . . . . f℥j.—M.

Useful in croupous conjunctivitis.

℞.—Trikresol . . . . gtt. j.
Distilled water . . . . . . f℥ij.—M.

In addition, *peroxide of hydrogen* in a 2-volume solution, *creolin* in a 1 per cent. solution, and *chlorine water* are also sometimes employed.

Astringent and Stimulating Remedies.

℞.—Sulphate of zinc . . . . . . gr. ss–ij.
Distilled water . . . . . . f℥j.—M.

℞.—Chloride of zinc . . . . . . gr. ss–ij.
Distilled water . . . . . . f℥j.—M.

℞.—Sulphocarbolate of zinc . . . . gr. ss–ij.
Distilled water . . . . . . f℥j.—M.

℞.—Alum . . . . gr. ss–ij.
Distilled water . . . . . . f℥j.—M.

℞.—Sulphate of copper . . . . . gr. ss–ij.
Distilled water . . . . . . f℥j.—M.

℞.—Boric acid . . . . gr. xl.
Chloride of sodium . . . . . gr. viij.
Camphor water,
Distilled water . . . . . āā f℥ij.—M.

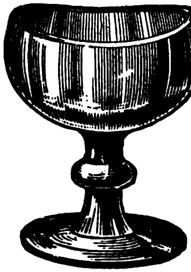
The formulæ just given are employed for *irrigations of the eye* where astringent and stimulating solutions are required, the indications for their use having been given in the text. If they are to be employed by the patient it is sometimes more conveniently done by means of an eye-cup rather than by a dropper.

The following remedies are employed for making *applications to the everted conjunctiva* where greater stimulation is desired:

℞.—Nitrate of silver . . . . . . gr. x.
Distilled water . . . . . . f℥j.—M.

One or two drops to be dropped into the conjunctiva immediately after the birth of the child as a preventive of ophthalmia neonatorum (Crédé's method). Solutions

FIG. 194.



Eye cup.

of silver nitrate should never be dropped into the eye for any continuous period. Also employed for *topical applications:*

℞.—Nitrate of silver	. . . . .	gr. ij.–xx.
Distilled water	. . . . .	f℥j.—M.

This is especially useful in purulent ophthalmia; the excess must always be washed off or neutralized with salt solution.

℞.—Solution of protargol	. . . . .	20–50 per cent.
℞.—Solution of argyrol	. . . . .	20–50 per cent.
℞.—Salicylate of sodium	. . . . .	gr. xl.
Salicylic acid	. . . . .	gr. j.
Distilled water	. . . . .	f℥viij.—M.

Useful in spring catarrh as well as in chronic conjunctivitis.

℞.—Sulphate of quinine	. . . . .	gr. ij.
Distilled water	. . . . .	f℥j.—M.

Useful in chronic conjunctivitis.

℞.—Tincture of opium . . . . . f℥j.
Distilled water . . . . . . f℥j.—M.

A stimulating solution for sluggish inflammations of the conjunctiva.

℞.—Tannin . . . . gr. xx–lx.
Glycerine . . . . f℥j.—M.

Useful as a topical application to the conjunctiva in follicular and granular conjunctivitis.

℞.—Solution of boroglyceride . . . . 25–50 per cent.

Useful as a topical application in granular conjunctivitis.

℞.—Crystals of iodine . . . . . gr. j–ij.
Purified petrolatum . . . . . ʒij.—M.

Useful as an application to the conjunctiva in granular lids with marked pannus.

Sulphate of copper and *alum* are sometimes employed in the form of a crystal made in the shape of a crayon for topical applications to the everted conjunctiva, the former being especially valuable in the cicatricial stage of granular lids, and the latter being of value in conjunctivitis with secretion and swelling of the follicles. The excess from the sulphate of copper application must be washed off.

Ointments.

℞.—Yellow oxide of mercury . . . . gr. ss–j.
Purified petrolatum . . . . . ʒj.—M.

℞.—Yellow oxide of mercury . . . . gr. ss–j.
Atropine . . . . gr. $\frac{1}{8}$–$\frac{1}{4}$.
Purified petrolatum . . . . . ʒj.—M.

To be employed in those cases in which a stimulating ointment is required and in which it is necessary to maintain mydriasis.

℞.—Ammoniated mercury . . . . . gr. j.
Purified petrolatum . . . . . ʒj.—M.

℞.—Boric acid . . . . gr. v–viij.
Purified petrolatum . . . . . ʒj.—M.

℞.—Zinc oxide ointment (U. S. P.).

To be used in excoriations of the eyelids.

℞.—Resorcin . . . . gr. ss–j.
Purified petrolatum . . . . . ʒj.—M.

Useful in marginal blepharitis where strong stimulation is required.

℞.—Sulphur . . . . gr. ss–j.
Purified petrolatum . . . . . ʒj.—M.

Also useful as a stimulating ointment in lid affections.

℞.—Iodoform . . . . gr. v–x.
Purified petrolatum . . . . . ʒj.—M.

Powders. *Calomel* is sometimes dusted on the cornea in cases of sluggish ulceration where active stimulation is required. It should not be employed in those patients who are taking the iodides, as the iodide of mercury will be formed and produce considerable irritation. *Iodoform* is also dusted upon the cornea in cases of marked suppuration, and should always be sterilized previous to its use.

Cycloplegics.

℞.—Sulphate of atropine . . . . . gr. iv.
Distilled water . . . . . . f℥j.—M.

It is customary to instil one drop of this solution three times a day; the effect upon the ciliary muscle does not completely wear off for about ten days.

℞.—Sulphate of duboisine . . . . gr. ij.
Distilled water . . . . . . f℥j.—M.

℞.—Hydrobromate of hyoscyamine . . gr. ij.
Distilled water . . . . . . f℥j.—M.

These solutions are also employed by instilling one drop three times a day. The effect upon the accommodation completely wears off in about five or six days.

℞.—Hydrobromate of scopolamine . . gr. j.
Distilled water . . . . . f℥j.—M.

The effect of this drug upon the accommodation wears off in about four days. As a rule, two or three instillations at ten-minute intervals are sufficient to produce the cycloplegic effect.

℞.—Hydrobromate of homatropine . . gr. j.
Distilled water . . . . . f℥j.—M.

This is the weakest of the cycloplegics, and complete paralysis of the accommodation cannot be obtained except by cumulative instillations. One drop should be instilled into each eye every ten minutes for an hour, and the eyes tested within the next hour, as its effect begins to wear off at the expiration of this period.

Solutions of atropine and of *hyoscyamine* twice as strong as those given are sometimes employed to break down the synechiæ in iritis. Whenever any of the cycloplegics are instilled the lacrymal punctum should be slightly everted and pressure made upon the tear duct to avoid absorption by the mucous membrane of the lacrymal duct and nose.

Some surgeons prefer to employ *gelatine disks* which contain these various drugs.

Myotics.

℞.—Sulphate of eserine . . . . gr. $^1/_{16}$–$^1/_{12}$.
Distilled water . . . . . f℥j.—M.

Employed in cases of chronic simple glaucoma.

℞.—Sulphate of eserine . . . . gr. $\frac{1}{2}$–ij.
Distilled water . . . . . f℥j.—M.

Employed in cases of acute inflammatory glaucoma.

℞.—Hydrochlorate of pilocarpine . . gr. $\frac{1}{8}$–$\frac{1}{6}$.
Distilled water . . . . . f℥j.—M.

Employed in cases of chronic simple glaucoma.

℞.—Hydrochlorate of pilocarpine . . gr. j–iv.
Distilled water . . . . . f℥j.—M.

Employed in acute inflammatory glaucoma.

The action both of myotics and mydriatics may be increased by the instillation of one or two drops of a solution of cocaine.

Local Anæsthetics. The use of these drugs has been described in the first part of this chapter.

Chemical Cauterants. These are used for cauterizing and stimulating a sluggish or progressive corneal ulcer. A direct application of one of the following substances is made by means of a pledget of absorbent cotton wrapped on the end of a sharpened stick or probe: *Pure carbolic acid, solution of formaldehyde* (1:50), *pure tincture of iodine, nitrate of silver* (gr. xxx–f℥j).

In those cases in which the chemical applications fail to check the progress of the disease it is sometimes necessary to use the *actual cautery.*

Miscellaneous Solutions. For the *detection of corneal abrasions* and the *diagnosis of corneal ulceration* a solution of fluorescine is employed.

℞.—Fluorescine	gr. iv.
Bicarbonate of sodium . . .	gr. v.
Distilled water	f℥ss.—M.

A drop of this solution is instilled into the conjunctival cul-de-sac and immediately washed out with a solution of boric acid. If the corneal epithelium is broken in any part that part will stain a bright green.

The *extract of the suprarenal capsule* is a powerful astringent and is sometimes employed to prevent or to check hemorrhage.

℞.—Suprarenal extract	gr. xx.
Distilled water (cold) . . .	f℥j.—M.

This should be allowed to stand for some minutes, and then filtered. The solution should be prepared fresh whenever required. *Adrenalin chloride* represents the active principle of the gland and keeps very well. The marked astringent effect may be obtained with a solution of 1:10,000.

℞.—Hydrochlorate of euphthalmine . . gr. iij.
Distilled water . . . . . . f℥j.—M.

Used for diluting the pupil for ophthalmoscopic examination. One instillation usually produces *mydriasis* in a half hour, the effect disappearing in two or three hours.

℞.—Tincture of opium,
Solution of subacetate of lead . āā f℥j.—M.
Add to a pint of water.

Cloths or absorbent cotton moistened with this solution are very useful in reducing excessive inflammatory œdema of the eyelids.

Application of Heat. Either moist or dry heat may be employed in ocular affections when required. Moist heat is usually obtained by means of *hot fomentations.* Small pieces of lint or flannel about 2½ inches in diameter are dipped into a basin of hot water about 120° F., and transferred to the closed lids. These should be changed every half minute or minute, and more hot water should be added from time to time to keep up the temperature. A very convenient method of keeping the water at a uniform hot temperature is to place an alcohol lamp with a small flame beneath the dish containing the water.

Dry heat may be employed by heating similar squares of lint or flannel and transferring them to the lids. It may also be employed by means of *Leiter's tubes,* consisting of a coil of tubes which is placed over the closed lids and a rubber tube connected at each end. Hot water is made to pass through this coil and is received into a basin from the other end. In using Leiter's tubes it is well to place a piece of lint between the tubes and the skin.

Application of Cold. A small ice bag filled with fine cracked ice may be laid directly over the eyelids, but more frequently cold is applied by means of *cold compresses.* A few squares of lint or flannel 2½ inches in

diameter are laid upon a block of ice and permitted to become thoroughly chilled; they are then transferred from the ice to the closed lids and changed every half minute or minute.

Cold may also be applied by means of Leiter's tubes, cold water being permitted to pass through the coil instead of hot water.

Electricity. Electricity is sometimes employed in affections of the eye, and may be either the *galvanic* or the *faradic* current according to requirement. Sometimes the electrode is applied to the closed lids, and at other times it is applied directly to the eyeball, local anæsthesia being previously induced.

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